

2.3 Urban Areas

2.3.1 Introduction

With approximately 80 percent of the nation's population living in coastal areas, controlling polluted runoff in urban areas is a challenge. Negative impacts of urbanization on coastal and estuarine waters are well documented in a number of sources, including California's Clean Water Act section 305(b) and section 319 reports and the Nationwide Urban Runoff Program.

Major pollutants found in runoff from urban areas include sediment, nutrients, oxygen-demanding substances, road salts, heavy metals, petroleum hydrocarbons, pathogenic bacteria, viruses, trash, and plastics. Suspended sediments constitute the largest mass of pollutant loadings to receiving waters from urban areas. Construction is a major source of sediment erosion. Petroleum hydrocarbons result mostly from automobile sources. Nutrient and bacterial sources include garden fertilizers, leaves, grass clippings, pet wastes, and faulty septic tanks. As population densities increase, a corresponding increase occurs in pollutant loadings generated from human activities. Many of these pollutants enter surface waters via runoff without undergoing treatment.

The control of urban nonpoint source (NPS) pollution requires the use of two primary strategies: the prevention of pollutant loadings and the treatment of unavoidable loadings. California's 15 urban management measures are organized to parallel the land use development process to address the prevention and treatment of NPS pollution loadings during all phases of urbanization; this strategy relies primarily on the watershed approach, which focuses on pollution prevention or source reduction practices. Pollution prevention and source reduction practices are favored over treatment practices because conducting education practices and incorporating pollution prevention practices into project planning and design activities are generally more effective, require less maintenance, and are more cost-effective in the long term than treatment strategies. Treatment strategies should be used only to address unavoidable loadings or where they are truly cost-effective.

The major opportunities to control NPS loadings occur during the following three stages of development: (1) the siting and design phase, (2) the construction phase, and (3) the post-development phase. Before development occurs, land in a watershed is available for a number of pollution prevention and treatment options, such as setbacks, buffers, or open space requirements, as well as wet ponds or constructed urban runoff wetlands that can provide treatment of the inevitable runoff and associated pollutants. In addition, siting requirements and restrictions and other land use ordinances, which can be highly effective, are more easily implemented during this period. After development occurs, these options may no longer be practicable or cost-effective. Management Measures [3.1A: Runoff from Developing Areas—Watershed Protection](#), [3.1B: Runoff from Developing Areas—Site Development](#), and [3.1C: Runoff from Developing Areas—New Development](#) address the strategies and practices that can be used during the initial phase of the urbanization process.

Urban Category Links:

Runoff from Developing Areas

→ [Watershed Protection](#)

→ [Site Development](#)

→ [New Development](#)

Runoff from Construction Sites

→ [Erosion and Sediment Control](#)

→ [Chemical Control](#)

Runoff from Existing Development

→ [Existing Development](#)

Onsite Wastewater Treatment Systems (OWTSs)

→ [New OWTSs](#)

→ [Operating OWTSs](#)

Transportation Development

→ [Planning, Siting, and Developing Roads and Highways](#)

→ [Bridges](#)

→ [Construction Projects](#)

→ [Chemical Control](#)

→ [Operation and Maintenance](#)

→ [Road, Highway, and Bridge Runoff Systems](#)

Education/Outreach

→ [Pollution Prevention/Education](#)

The control of construction-related sediment loadings is critical to maintaining water quality. The implementation of proper erosion and sediment control practices during the construction stage can significantly reduce sediment loadings to surface waters. Management Measures [3.2A: Runoff from Construction Sites—Construction Site Erosion and Sediment Control](#) and [3.2B: Runoff from Construction Sites—Construction Site Chemical Control](#) address construction-related practices.

After development has occurred, lack of available land severely limits the implementation of cost-effective treatment options. Management Measure [3.3A: Runoff from Existing Development—Existing Development](#) addresses strategies for reducing NPS pollution in already-developed areas. Management Measures [3.4A: Onsite Wastewater Treatment Systems—New OWTs](#) and [3.4B Onsite Wastewater Treatment Systems—Operating OWTs](#) describe practices to properly install innovative wastewater treatment systems and to reduce pollution from improperly designed or maintained septic tanks and treatment systems. Management Measures [3.5A: Transportation Development—Planning, Siting, and Developing Roads and Highways](#), [3.5B: Transportation Development—Bridges](#), [3.5C: Transportation Development—Construction Projects](#), [3.5D: Transportation Development—Chemical Control](#), [3.5E: Transportation Development—Operation and Maintenance](#), and [3.5F: Transportation Development—Road, Highway, and Bridge Runoff Systems](#) address runoff from transportation infrastructure, including the activities involved in building and maintaining roads, highways, and bridges.

Finally, Management Measure [3.6A: Education/Outreach—Pollution Prevention/Education](#) can be used to reduce the amount of pollutants generated or allowed to be exposed to runoff.

2.3.1.1 State Water Resources Control Board (SWRCB) and Regional Water Quality Control Boards (RWQCB) NPDES Storm Water Program

The urban NPS Program and Storm Water Programs are intricately linked in that both programs address aspects of urban runoff pollution. With respect to programs within the SWRCB and the RWQCBs, urban runoff is addressed primarily through the National Pollution Discharge Elimination System (NPDES) Permitting Program, although the SWRCB NPS Program will apply where the runoff is not regulated as a permitted point source discharge.

This permitted “point source” system of addressing urban runoff pollution is the result of the Water Quality Act of 1987, which amended the federal Clean Water Act to require NPDES permits for certain categories of storm water discharges. These “categories” of storm water discharges are described as follows:

Phase I of the Storm Water Program, defined in federal regulation in 1990, includes storm water discharges associated with “industrial” activities (as defined by the regulations), construction activities that disturb five acres of land or more, and discharges from municipal separate storm sewer systems (MS4s) serving populations of 100,000 people or more. Phase II of the Storm Water Program, defined in federal regulations in 1999, expanded the program to require NPDES permits for discharges from construction sites disturbing between one and five acres, from small MS4s that serve populations of less than 100,000, from some other governmental facilities, and from industrial facilities owned by small municipalities. The expansion of the Storm Water Program through Phase II has therefore expanded the applicability of the NPDES point source program to a greater number of communities, businesses, government facilities, and industries. The result is that most urban runoff in California is now subject to NPDES permits.

The expansion of the storm water NPDES program has resulted in applying NPDES requirements in areas where NPS was previously the sole regulatory program. It is important to understand that the NPDES Program supercedes the SWRCB or RWQCB NPS Program in the areas where there is overlap. NPDES

permits require implementation of management practices, which may or may not be similar to the management measures and management practices of the NPS Program. However, the SWRCB/RWQCB's NPDES Program does not supercede the planning and land-use activities of other State agencies, such as the California Coastal Commission or the San Francisco Bay Conservation and Development Commission, which they are responsible for implementing under their own regulatory authorities.

The SWRCB/RWQCB NPDES permits are at least as stringent as the NPS Program and will ensure at least the same level of compliance and water quality protection as the NPS Program's management measures provide. Further, the authority of the SWRCB/RWQCB NPS Program will still apply for land use activities not covered by NPDES permits and for municipalities, construction sites, and industries that fall outside of the Phase I and Phase II Storm Water Programs.

2.3.2 General Resources

- **Denver Urban Drainage and Flood Control District, Urban Storm Drainage Criteria Manual, Volume 3** (<http://www.udfcd.org/usdcm/vol3.htm>): This manual contains information on management practices and maintenance considerations for storm water in urban areas. The manual includes chapters on both structural and nonstructural management practices, as well as practices specific to construction, industrial, new development, and redevelopment activities.
- **USEPA, BASINS: Better Assessment Science Integrating Point and Nonpoint Sources** (<http://www.epa.gov/waterscience/basins/>): This tool, used for managing watersheds, integrates national watershed data and state-of-the-art environmental assessment and modeling tools into a geographic information system. The EPA Web site allows users to download the application and access documentation, metadata, frequently asked questions, training, an online forum, and other tools and utilities.
- **USEPA, Nonpoint Source News-Notes** (<http://www.epa.gov/owow/info/NewsNotes/>): Nonpoint Source News-Notes is an online bulletin published by EPA that covers a wide range of topics, including nonpoint source pollution control, watershed restoration, and ecosystem-driven management. The Web interface allows users to search current and back issues of News-Notes by keyword.
- **USEPA, Stormwater Case Studies** (<http://cfpub.epa.gov/npdes/stormwater/casestudies.cfm>): This Web site provides a series of storm water case studies to help communities with municipal separate storm sewer systems (MS4s) regulated under the NPDES Phase II Rule get started on or improve their storm water management programs. Each case study description includes links to additional materials for the relevant storm water program area.
- **G. Fred Lee and Associates, Stormwater Runoff Science/Engineering Newsletter** (<http://www.gfredlee.com/newsindex.htm>): This newsletter is devoted to stormwater-runoff water quality issues in managing urban and agricultural stormwater runoff water quality impacts. The newsletter can be searched by topic or volume, and publications on other topics, including landfills, watersheds, contaminated sediment, reclaimed waters, hazardous chemicals, water quality, domestic water, and excess fertilization, can also be found on this site.

2.3.3 Management Measure 3.1A Runoff from Developing Areas Watershed Protection

Fact Sheet Links:

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- [Case Studies](#)
- [References](#)

Management Measure

Develop a watershed protection program to

1. Avoid conversion, to the extent practicable, of areas that are particularly susceptible to erosion and sediment loss;
2. Preserve areas that provide important water quality benefits and/or are necessary to maintain riparian and aquatic biota;
3. Protect to the extent practicable the natural integrity of water bodies and natural drainage systems associated with site development—including roads, highways, and bridges;
4. Limit increases of impervious surfaces; and
5. Provide education and outreach to address sources of NPS pollution.

The intent of this management measure is to encourage land use and development planning on a watershed scale that takes into consideration sensitive areas that, by being protected, will maintain or improve water quality. Each element of the management measure addresses key issues that result in water quality degradation. Progress can be made when these issues are addressed holistically in a watershed-wide plan.

2.3.3.1 Programs

The California Department of Conservation, Division of Land Resource Protection, provides to landowners information on grants and financial assistance, mapping, and technical resources for protecting natural resources (<http://www.consrv.ca.gov/DLRP/index.htm>).

Through the Clean Water Act (CWA) section 401 certification program, RWQCBs review projects that require a federal permit under CWA section 404 or that involve dredge or fill activities that may result in a discharge to waters of the United States. This is to ensure that the State's interests are protected on any federally permitted activity occurring in or adjacent to waters of the State. Detailed information about CWA section 401 in California, including a description of the program, resources, legal background information, proposed projects, and links, are described on the SWRCB Web site (<http://www.swrcb.ca.gov/cwa401/index.html>).

The California Department of Fish and Game (DFG) may regulate a project through the Streambed Alteration Agreement process. DFG issues Streambed Alteration Agreements when project activities have the potential to impact intermittent and perennial streams, rivers, or lakes (<http://www.dfg.ca.gov/1600/>).

The Watershed Information Technical System (WITS), developed by the California Environmental Resources Evaluation System (CERES), is a program that provides the information and tools to support

local watershed planning, restoration, monitoring, and education. CERES and WITS are programs of the California Resources Agency (<http://ceres.ca.gov/watershed/>).

California Environmental Quality Act: If CEQA compliance is required (if the project is not found to be exempt based on the current CEQA Guidelines), a local or State agency must act as the lead CEQA agency. More information about CEQA can be found at (<http://ceres.ca.gov/ceqa/>).

2.3.3.2 Management Practices

Part 1 of the management measure states that areas particularly susceptible to erosion and sediment loss, specifically areas with highly erodible soils or steep slopes, should be avoided when siting new developments. Arendt (1996) developed a process by which a development envelope could be defined based on factors such as soil type, slope, ecological significance, floodplain delineations, existing vegetation, and cultural/historical significance. On a larger scale, undeveloped areas can be ranked by overlaying data sets in a geographic information system (GIS) that describes factors such as those listed above to guide decisions regarding zoning classification.

The second part of the management measure deals with protecting areas that provide water quality benefits, including protection of riparian vegetation and wildlife. Wetlands and riparian areas can be protected by local governments through the implementation of buffer ordinances. In addition, landowners can choose to implement buffers and setbacks on their property and to protect wetlands and other ecologically sensitive areas from development. To formalize this process of protecting water resources, a variety of conservation mechanisms can be used, such as easements, deed restrictions, and covenants. Developers should be encouraged to protect water resources as a selling point (aesthetic and ecological amenity).

The third part of the management measure deals with protecting the integrity of water resources from the effects of site development and infrastructure. This can be accomplished by establishing setbacks from natural drainage areas and using vegetated buffers to provide additional protection. In addition, culverts and crossings can be designed to minimize impacts on riparian areas and to enhance natural drainage rather than impede or overwhelm it. Finally, grading plans can be designed to minimize the adverse hydrologic impacts of clearing and the creation of impervious areas by dispersing drainage to multiple outlets so as not to overwhelm a single drainage feature.

The fourth part of the management measure proposes limiting increases of impervious surfaces. Developers can use innovative site and structure designs that reduce building footprints, decrease the amount of paved infrastructure, and provide for dispersed drainage and infiltration of runoff from impervious surfaces to reduce “effective impervious surface,” which can be defined as impervious surface that is connected to the storm water drainage system. The concept of effective impervious surface is important, because when runoff from these surfaces is directed to pervious areas rather than to an impervious drainage system (i.e., curbs, gutters, street surfaces, storm drain pipes), it can infiltrate, evaporate, or be taken up by vegetation, thereby reducing the total volume of runoff leaving a site.

The fifth part of the management measure deals with education and outreach regarding NPS pollution. There are abundant opportunities to involve the public in NPS pollution management, including distributing educational materials, holding training sessions and workshops, involving the public in water resource-specific activities such as cleanups and festivals, and encouraging stakeholder involvement in water resource-related decisions via public hearings and meetings. These activities can be focused on high-priority water bodies, groups who contribute to pollution (e.g., lawn care professionals, homeowners with yards, pet owners), or specific demographic groups (e.g., Spanish-speaking populations, school children).

2.3.3.3 Information Resources

Data for Watershed Evaluations and Determination of Site Characteristics

- **Natural Resources Conservation Service Soil Maps** (<http://soils.usda.gov/survey/>): Soil maps and electronic data available from the Natural Resources Conservation Service can be used to identify areas with highly erodible soils, and topographic maps and data can be purchased from the U.S. Geological Survey and used to identify steep slopes. To view a list of available soil surveys and to obtain soil maps, contact the State Conservationist or access the Soil Survey Request Form.
- **U.S. Fish and Wildlife Service, Pacific Region Field Offices** (<http://pacific.fws.gov/ecoservices> for Ecological Services staff contact information): Critical Habitat Areas for endangered species can be identified with the assistance of the Fish and Wildlife Service Pacific Region Field Offices in Yreka, Arcata, Red Bluff, Sacramento, Barstow, and Ventura.
- **The California Office of Historic Preservation** (<http://ohp.parks.ca.gov/>): The Office of Historic Preservation can provide guidance on identifying and conserving cultural or historical resources and meeting the requirements of CEQA, the National Environmental Policy Act (NEPA), and the National Historic Preservation Act (NHPA) regulations.
- **The California Watershed Assessment Manual** (<http://cwam.ucdavis.edu/>): This Web site provides a variety of tools to guide the process of watershed assessment. Included on this Web site are summaries of key topics related to watershed assessment, details on how to conduct a watershed assessment, and links to other resources.

Land and Water Resource Conservation Options

- **Stormwater Manager's Resource Center** (<http://www.stormwatercenter.net/>): The Stormwater Manager's Resource Center provides resources for those involved in local storm water management. These resources include a monitoring/assessment section that details environmental indicators, methods, factors to consider in an assessment, and assessment tools and models. The Web site also has articles about land conservation, open space ordinances, and a fact sheet on conservation easements.
- **Nonpoint Education for Municipal Officials (NEMO)** (<http://nemo.uconn.edu/>): NEMO offers guidance, research studies, data, and land use planning tools to help local officials make land use decisions that will protect natural resources.
- **The National Management Measures to Control Nonpoint Source Pollution from Urban Areas** (<http://www.epa.gov/owow/nps/urbanmm>): Chapter 3 of this guidance manual from USEPA has a review of the various options available for land and water resource conservation (USEPA, 2005).
- Nonprofit conservation organizations: Information about land and water resource conservation for landowners is available from several nonprofit organizations, including the **Land Trust Alliance** (<http://www.lta.org/>), **The Conservation Fund** (<http://www.conservationfund.org/>), and the **Natural Lands Trust** (<http://www.natlands.org/>).
- **Wildlife Reserves and Corridors in the Urban Environment: A Guide to Ecological Landscape Planning and Resource Conservation** (<http://users.erols.com/urbanwildlife/bookstor.htm>): This book by Lowell Adams and Louise Dove reviews the knowledge base regarding wildlife habitat reserves and corridors in urban and urbanizing areas and provides guidelines and approaches to

ecological landscape planning and wildlife conservation in such areas. It can be purchased from the Urban Wildlife Resources Bookstore at the Web site listed above.

- **Growing Greener: Putting Conservation into Local Codes** (<http://www.dcnr.state.pa.us/growinggreener/growinggreener.htm>): Growing Greener is a statewide community planning initiative designed to help communities use the development regulation process to their advantage to protect interconnected networks of greenways and permanent open space. The booklet can be downloaded as a PDF file at the Web site listed above.
- **Smart Growth Network** (<http://www.smartgrowth.org/>): The Smart Growth Network is a nationwide effort coordinated by USEPA's Urban and Economic Development Division. USEPA is working through cooperative partnerships with a diverse network of organizations to encourage development that better serves the economic, environmental, and social needs of communities. The network provides a forum for information-sharing, education, tool development and application, and collaboration on smart growth issues. Smart growth approaches focus on flexible zoning, preventive planning, intelligent management of natural resources and water quality, and implementation of treatment and control technologies at multiple scales from development sites to watershed planning.
- **Northeastern Illinois Planning Commission** (<http://www.nipc.org/pubs-services/>): The Northeastern Illinois Planning Commission (NIPC) published *Model Stream and Wetland Protection Ordinance for the Creation of a Lowland Conservancy Overlay District: A Guide for Local Officials*. The model ordinance can be ordered from the NIPC publications Web site.
- **Green Infrastructure Web site** (<http://www.greeninfrastructure.net/>): The concept of creating and maintaining an interconnected network of protected land and water is called Green Infrastructure. Green Infrastructure supports native species, maintains natural ecological processes, sustains air and water resources, and contributes to health and quality of life. This Web site, developed by The Conservation Fund with support from USDA Cooperative Forestry, contains information to aid in implementing a comprehensive conservation program and includes resources such as searchable profiles, training information, events, and references databases.
- ***Institutional Aspects of Urban Runoff Management: A Guide for Program Development and Implementation***: This manual was developed to assist individuals responsible for developing and implementing urban erosion, sediment control, and storm water management programs. The document presents a comprehensive review of the institutional frameworks of successful urban runoff management programs, including summaries of state, regional, county, and municipal urban runoff programs. The manual can be purchased online at: http://www.stormwater.ucf.edu/publications/urban_runoff.pdf.
- **USEPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters** (http://www.epa.gov/owow/nps/watershed_handbook): The Handbook is intended to assist watershed planners and others on nearly all aspects of the watershed planning process. The focus of the Handbook is on the nonpoint source water quality aspects of watersheds, but it is designed to take the user through each step of the watershed planning process, including watershed monitoring and assessment, community outreach, selection and application of available models, BMP effectiveness databases, implementation, feedback and plan adjustment, and more.
- **USEPA Growing Toward More Efficient Water Use: Linking Development, Infrastructure, and Drinking Water Policies** (http://www.epa.gov/smartgrowth/water_efficiency.htm): This publication focuses on the relationship between development patterns, water use, and the cost of water delivery. It reviews literature that shows how large-lot, dispersed development patterns cost more to serve because of the length of pipe required, pumping costs, and other factors. The literature also shows that large-lot, dispersed development uses more water. The document

includes policy options for states, localities, and utilities that directly reduce the cost and demand for water, while indirectly promoting smart growth.

- **USEPA Using Smart Growth Techniques as Stormwater Best Management Practices** (<http://www.epa.gov/smartgrowth/stormwater.htm>): This report reviews nine common smart growth techniques (regional planning, infill development, redevelopment policies, special development districts (e.g., transit oriented development and brownfields redevelopment), tree and canopy programs, parking policies to reduce the number of spaces needed or the footprint of the lot, “fix it first” infrastructure policies, smart growth street designs, and stormwater utilities) and examines how they can be used to prevent or manage stormwater runoff. The document provides an overview of the relationship between land development patterns and water quality and quantity, and it provides sections for resources and a case study from New Jersey.
- **USEPA Protecting Water Resources with Higher-Density** (http://www.epa.gov/smartgrowth/water_density.htm): This report is intended to help clarify the role of high-density development in protection of water resources and green space. The report includes a discussion of the impacts of development, a description of critical land use components for the protection water quality, a critique of the conventional wisdom that low-density development best protects water resources, and a presentation of the alternative view that compact development can minimize water quality impacts on a regional scale. The report also features the results of an exercise to model 3 development scenarios at different scales and different time-series build-out scenarios.

Buffer Resources

- **Model Ordinances to Protect Local Resources Web site** (<http://www.epa.gov/owow/nps/ordinance>): USEPA published this Web site to provide model ordinance language and examples of ordinances that have been implemented by municipalities across the country.
- **Ordinance on Riparian Habitat Areas, City of Napa, California** ([http://www.stormwatercenter.net/Model Ordinances/napa_buffer_ordinance.htm](http://www.stormwatercenter.net/Model%20Ordinances/napa_buffer_ordinance.htm)): The City of Napa has implemented an ordinance to protect riparian areas that can be used as an example by other California municipalities.
- **Buffer Strips: Common Sense Conservation** (<http://www.nrcs.usda.gov/feature/buffers/>): This USDA NRCS Web site features information on buffers including background information about the USDA NRCS buffer initiative and the benefits of buffers, technical information for implementing buffers, contacts that can provide assistance with buffer establishment, and examples of successful buffer implementation. A list of contacts can be found at this site as well. California-specific information about buffers can be found at <http://www.ca.nrcs.usda.gov/programs/buffer.html>.
- ***Vegetated Stream Riparian Zones: Their Effects on Stream Nutrients, Sediments, and Toxic Substances*** (<http://www.unl.edu/nac/ripzone03.htm>): This Web site presents an annotated and indexed bibliography of buffer strip literature.

Impervious Area Reduction/Innovative Site Designs

- **The Center for Watershed Protection** (<http://www.cwp.org/>): This nonprofit organization has produced several publications and other technical resources to help planners implement better site

design techniques to reduce storm water from impervious surfaces. Specifically, the *Rapid Watershed Planning Handbook*, published in 1998, describes techniques that communities can use to more effectively protect and restore water resources.

- **The Low Impact Development Center Web site** (<http://www.lowimpactdevelopment.org/>): This nonprofit organization's Web site provides technical references for implementing low impact development techniques and has case studies of sites where these practices have been successfully implemented.
- **Huron River Watershed Council, *A Guidebook on Using Impervious Surface and Gravel Road Capacity Analysis to Manage Growth in Rural and Suburban Communities*** (http://www.hrwc.org/pdf/PAL_Guidebook.pdf): This Guidebook offers a research-based approach to land planning with regard to water quality and the capacity of gravel roads to handle vehicle traffic. The intent of the Guidebook is to demonstrate how to match levels of development to the natural system's ability to absorb runoff and the ability of gravel roads to handle traffic.
- **USEPA, Watershed Academy Web Module** (<http://www.epa.gov/watertrain/smartgrowth/>): This training module explains how changes in land use can impact water resources and presents national data on trends in development patterns and activities on land that have become increasingly significant challenges for achieving water quality standards. The module suggests various methodologies used to accommodate future growth in a way that is beneficial to both the economy and the environment. The module also includes a "tools" section with links to on-line resources.
- **Nonpoint Education for Municipal Officials (NEMO), Impervious Surfaces** (http://www.nemo.uconn.edu/impervious_surfaces/): This University of Connecticut educational program, created for land use officials, addresses the relationship of land use to natural resource protection. NEMO has long been associated with the topic of impervious surfaces and now provides the following information on their Web site for those interested in preventing and/or mitigating the impacts of urbanization on water resources: Planning and Design, Estimating and Mapping, and Data and Maps. Links providing additional information and studies pertaining to impervious surfaces are also available on this site.

2.3.3.4 References

Arendt, R. 1996. *Conservation Design for Subdivisions*. Island Press, Washington, DC.

USEPA. 2005. *National Management Measures to Control Nonpoint Source Pollution from Urban Areas*. EPA 841-B-05-004. U.S. Environmental Protection Agency, Washington, DC.
(<http://www.epa.gov/owow/nps/urbanmm>)

2.3.4 Management Measure 3.1B Runoff from Developing Areas Site Development

Fact Sheet Links:

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- [Case Study](#)
- [References](#)

Management Measure

Plan, design, and develop sites to

1. Protect areas that provide important water quality benefits necessary to main riparian and aquatic biota, and/or are particularly susceptible to erosion and sediment loss;
2. Limit increases of impervious areas;
3. Limit land disturbance activities such as clearing and grading, and cut-and-fill to reduce erosion and sediment loss; and
4. Limit disturbance of natural drainage features and vegetation.

2.3.4.1 Programs

Through the Clean Water Act (CWA) section 401 certification program, RWQCBs review projects that require a federal permit under CWA section 404 or that involve dredge or fill activities that may result in a discharge to waters of the United States. This is to ensure that the State's interests are protected on any federally permitted activity occurring in or adjacent to waters of the State. Detailed information about CWA section 401 in California, including a description of the program, resources, legal background information, proposed projects, and links, are described on the SWRCB Web site (<http://www.swrcb.ca.gov/cwa401/index.html>).

The California Department of Fish and Game (DFG) may regulate a project through the Streambed Alteration Agreement process. DFG issues Streambed Alteration Agreements when project activities have the potential to impact intermittent and perennial streams, rivers, or lakes. More information about this program can be found at DFG's Web site (<http://www.dfg.ca.gov/1600/>).

California Environmental Quality Act: If CEQA compliance is required (if the project is not found to be exempt based on the current CEQA Guidelines), a local or State agency must act as the lead CEQA agency. More information about CEQA can be found at <http://ceres.ca.gov/ceqa/>.

2.3.4.2 Management Practices

Development sites should be evaluated to identify areas that are less suitable for development (i.e., steep slopes, erodible soils, wetlands, land within the 100-year floodplain, and historically or culturally significant areas. Building footprints and infrastructure should be located away from these areas where feasible. Local governments can enact ordinances to protect specific resources such as wetlands or riparian areas, and landowners can be encouraged to voluntarily practice conservation of ecologically significant areas.

Traditional post-World War II development patterns dictate wide streets, large setbacks from the street (resulting in long driveways), and sidewalks on both sides of the street. These infrastructure patterns

create an excess of impervious surface, which generates more runoff than would undeveloped land, grass, and other landscaped areas. Exacerbating this problem is the fact that most modern developments have curb and gutter systems to efficiently collect and rapidly convey this runoff to natural drainage systems, which can overwhelm the receiving water body and result in flooding and water quality degradation.

In recent years, techniques have been developed to redesign traditional subdivisions and commercial properties to reduce the amount of land converted to impervious surfaces. These techniques have many names—including cluster development, open space design, better site design, and low impact development—but a common feature of all of them is to reduce the amount of impervious surfaces created on a particular site. This might involve any of the following practices:

- Designing streets to be narrower
- Placing sidewalks on only one side of the street
- Providing pervious areas for on-street parking
- Redesigning the layout of buildings to reduce street length and preserve open space
- Reducing setbacks for houses
- Reducing parking lot sizes to reflect actual usage
- Promoting shared parking among nearby businesses with different peak demands for parking (e.g., churches and retail businesses)
- Disconnecting impervious surfaces through creative grading plans and distributed infiltration areas

These techniques, among others, can be used as appropriate to reduce the impact of an individual development site on receiving waters. Municipalities can require that these types of practices be implemented through an ordinance that provides modified, environmentally friendly standards for infrastructure dimensions and layouts. In addition, these practices can be encouraged through storm water credits or density credits provided as incentives to developers.

To limit land disturbance activities, developers and construction site contractors can practice site fingerprinting, which is a technique that reduces the amount of land disturbed on a development site to that which will be built upon. Site fingerprinting entails flagging off areas where vegetation is to be preserved so that heavy equipment will not be driven over those areas and so that stockpiles will be placed elsewhere. Signage and other training/education materials for construction site workers are essential to ensure that the protected areas remain undisturbed.

2.3.4.3 Information Resources

- ***California New Development and Redevelopment Handbook*** (<http://www.cabmphandbooks.org/>): Section 2 of this manual contains information about storm water quality planning for new development and redevelopment, including permit requirements, planning principles, techniques for reducing runoff and managing impervious areas, source controls, runoff treatment controls, modifying development layouts, conducting a site evaluation, and selecting management practices. Section 3 discusses how site layouts should be designed to reduce water quality impacts.

- **National Menu of Best Management Practices for Storm Water Phase II, Post-Construction Storm Water Management in New Development and Redevelopment Fact Sheets** (<http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post.cfm>): USEPA's guidance for small NPDES-regulated municipalities details several site design practices to reduce the amount of storm water generated on a development site and to disconnect impervious surfaces from the municipal separate storm sewer system. Especially useful for this management measure are the fact sheets listed under "On-lot Treatment" and "Better Site Design."
- **Center for Watershed Protection Resources** (<http://www.cwp.org/>): The *Consensus Agreement on Model Development Principles to Protect Our Streams, Lakes, and Wetlands* outlines the series of 22 nationally endorsed principles developed by the Site Planning Roundtable, a national cross section of diverse planning, environmental, home builder, fire, safety, public works, and local government personnel, and details basic rationale for their implementation. Also, *Better Site Design: A Handbook for Changing Development Rules in Your Community* outlines 22 guidelines for better developments and provides detailed rationale for each principle. *Better Site Design* also examines current practices in local communities, details the economic and environmental benefits of better site designs, and presents case studies from across the country. The Center also provides technical information about reducing impervious surfaces in new developments.
- **Growing Greener: Putting Conservation into Local Codes** (<http://www.dcnr.state.pa.us/growinggreener/growinggreener.htm>): In 1997 Randall Arendt of the Natural Lands Trust, Inc., published *Growing Greener*, which is a statewide community planning initiative designed to help communities use the development regulation process to their advantage to protect interconnected networks of greenways and permanent open space.
- **Low Impact Development Center** (<http://www.lowimpactdevelopment.org/>): This nonprofit organization's Web site has technical resources and case studies that illustrate successful implementation of low impact development techniques.
- **Low-Impact Development Design Strategies: An Integrated Design Approach** (EPA-841-B-00-003) and **Low-Impact Development Hydrologic Analysis** (EPA-841-B-00-002), both developed by the Prince George's County, Maryland, Department of Environmental Resources, discuss site planning, hydrology, distributed integrated management practice technologies, erosion and sediment control, and public outreach techniques that can reduce storm water runoff from new and existing developments. Both publications can be ordered free of charge through USEPA's National Service Center for Environmental Publications at <http://www.epa.gov/ncepihom/index.htm>.
- **Low Impact Development Technologies** (<http://www.wbdg.org/design/resource.php?cn=o&cx=O&rp=70>): This Web site provides information on low impact development as an alternative site design strategy that uses natural and engineered infiltration and storage technologies to control storm water where it is generated.
- **Residential Streets**, prepared by the American Society of Civil Engineers, the National Association of Home Builders, and the Urban Land Institute, discusses design considerations for residential streets based on their function and their place in the neighborhood. The publication presents guidance on street widths, speeds, pavement types, streetscapes, rights-of-way, intersections, and drainage systems. It can be ordered online at <http://www.amazon.com/> or other online booksellers.
- **Traditional Neighborhood Development—Street Design Guidelines** (<http://www2.lgc.org/bookstore/list.cfm?categoryId=1>) The Institute of Transportation Engineers (ITE) published this manual, which details traditional neighborhood designs that foster pedestrian movement in place of automobile traffic are discussed and design concepts such as on-street

parking, street width, and sight distances are presented. The publication also includes a practical discussion of the time needed for community acceptance and travel behavior changes. ITE also published ***Guidelines for Residential Subdivision Street Design*** (1993), which presents a discussion of the overall design of a residential subdivision with respect to the adequacy of vehicular and pedestrian access, minimizing excessive vehicular travel, and reducing reliance on extensive traffic regulations. It also includes design considerations for local and collector streets and intersections, including such topics as terrain classifications, rights-of-way, pavements, curb types, and cul-de-sacs. These publications are available through the ITE's online bookstore.

- **Reduced Width Street Standards Database** (<http://www.sonic.net/abcaia/narrow.htm>): The Congress for the New Urbanism has compiled a database of jurisdictions across the country that have adopted reduced width street standards. The database also includes resources related to neighborhood design and transportation.
- **International Stormwater BMP Database** (<http://www.bmpdatabase.org/>): This Web site provides access to information on BMP performance for studies conducted over the past 15 years. Users can search these data to assess the appropriateness for use of management practices under various conditions.
- **Green Development Literature Search** (http://www.smartgrowth.org/bibliographies/greenlit_search/green_lit.html): This document is a collection of examples, case studies, and issues related to urban development and the implementation of Green Development, prepared for USEPA's Office of Wetlands, Oceans, and Watersheds. Information contained in this collection can be used to promote better approaches to development and management of development impacts through the use of alternative site planning, zoning, grading, natural resources protection, site layout, and storm water management options.
- **California Nevada Cement Promotion Council, Pervious Concrete Pavement** (<http://www.cncpc.org/pages/pervious.html>): Pervious concrete pavement and porous asphalt can be used for storm water management. These road surfaces are designed to allow rainwater to pass through the surface to infiltrate the soil below. Benefits from this practice include filtration of pollutants, decreased flows to storm sewers, groundwater recharge, and reduced erosion. The California Nevada Cement Promotion Council provides links to projects using these surfaces. In addition, an article in *Land Development Today* offers additional details of this practice (<http://www.landdevelopmenttoday.com/Article90.htm>).
- **Bay Area Stormwater Management Agencies Association, *Start at the Source: Design Guidance Manual for Stormwater Quality Protection*** (http://www.scvurppp-w2k.com/basmaa_satsm.htm): The Bay Area Stormwater Management Agencies Association has produced a guidance manual to help city planners and resource managers focus on the importance of considering storm water quality in the early stages of planning and designing new land development projects. This manual reviews storm water management practices and provides technical information and case studies related to management practice implementation. This guidance is accompanied by a handbook, *Using Start at the Source to Comply with Development Standards*.

2.3.4.4 Case Study

Jordan Cove Urban Watershed Section 319 National Monitoring Program Project. The Jordan Cove Urban Watershed Section 319 National Monitoring Program Project is a ten-year study designed to examine the water quantity and quality benefits of the development of an urban subdivision using pollution prevention management practices. For this study, two watershed developments were

constructed, a traditional watershed developed using ‘traditional’ subdivision requirements and a management practice watershed developed using a management practice approach before, during, and after construction. Storm water runoff from three watersheds—control, traditional, and management practice—is monitored, and the runoff from the two experimental watersheds is compared to an existing control watershed. The goal of this study is to show that, by using a management practice approach, pre-development hydrologic conditions can be maintained during and after residential development (<http://www.canr.uconn.edu/jordancove/>).

2.3.5 Management Measure 3.1C Runoff from Developing Areas New Development

Fact Sheet Links:

- [Programs](#)
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*Management Measure***1. By design or performance:**

After construction has been completed and the site is permanently stabilized, reduce the average annual total suspended solids (TSS) loadings by 80 percent (for the purposes of this measure, an 80 percent TSS reduction is to be determined on an average annual basis); or

Reduce the post-development loadings of TSS so that the average annual TSS loadings are no greater than pre-development loadings.

2. To the extent practicable, maintain post-development peak runoff rate and average volume at levels that are similar to pre-development levels.

The first part of this management measure addresses increased pollutant loads associated with developed lands. The second part of this management measure addresses the hydrologic alterations resulting from development that affects runoff volume and timing. Developers can use innovative site planning techniques or incorporate runoff management practices to reduce the hydrologic impact of development on receiving waters.

2.3.5.1 Programs

NPDES Storm Water Program. Most urban runoff is regulated under the NPDES permitting program as point source discharges from municipally owned or operated separate storm sewer systems (MS4s). This program has requirements distinct from those of the NPS program, although the same set of management practices is appropriate for controlling pollutants from both storm water and nonpoint sources. The specific requirements for owners and operators of MS4s depend on the municipality's or public entity's population size and water quality concerns. More information about the requirements can be found at California's Storm Water Program Web site (<http://www.swrcb.ca.gov/stormwtr/>).

2.3.5.2 Management Practices

In urban areas that do not meet the criteria to be covered under the NPDES storm water regulation, the NPS program requires that owners of new developments implement management practices to meet the requirements of the management measure described above. There are two parts to the requirement: first, runoff quality must be addressed by implementing treatment controls that remove at least 80 percent of the average annual TSS loadings in runoff. TSS is used as a measure of pollutant removal effectiveness because it is a common pollutant in urban runoff and is often associated with other pollutants such as nutrients and heavy metals. The second part of the management measure directs developers to implement practices to control the timing and volume of runoff leaving the site such that it mimics the hydrology of the site before development. The adverse impacts of increased hydraulic loadings to urban streams are well documented and include channel widening, instream and riparian habitat loss, increased pollutant loads, temperature impacts, and increased erosion of streambanks and streambeds, to name a few.

The NPS management measures do not specify a single method that should be used to achieve this level of pollutant removal, which allows developers flexibility in meeting both the 80 percent TSS removal and pre-development hydrology criteria. The types of technologies that can be used to achieve both criteria include detention ponds/vaults, retention ponds and wetlands, infiltration practices, filtration practices, open channel practices, and various proprietary practices, as described in the following:

- Temporary *detention ponds or vaults* that hold runoff and release it slowly but completely after a 72-hour or shorter period.
- *Retention pond or wetlands* in which a permanent pool of water is maintained and runoff is slowly released over time. Retention practices, by allowing water to stand for a longer period of time, achieve greater pollutant removal through settling and allow for biological uptake using wetland vegetation.
- *Infiltration practices*, such as basins, trenches, and French drains, collect runoff and convey it through a porous matrix into the ground water.
- *Filtration practices*, such as sand or organic filters and bioretention practices, act similarly to infiltration practices but area designed to achieve greater pollutant removal and have limited hydraulic loading capacities.
- *Open channel practices*, such as grassed swales, are commonly and effectively used to collect, convey, and infiltrate runoff, but they are not intended to drain large areas of impervious surfaces and therefore are typically implemented in combination with other practices.
- *Proprietary practices* that are typically installed underground use mechanisms such as settling, absorption, and microfiltration as well as other mechanisms such as centrifugal force and gross filtration to remove solids and floatable debris.

2.3.5.3 Information Resources

- **California New Development and Redevelopment Handbook** (<http://www.cabmphandbooks.org/>): Section 2 of this manual contains information about storm water quality planning for new development and redevelopment, including permit requirements, planning principles, techniques for reducing runoff and managing impervious areas, source controls, runoff treatment controls, modifying development layouts, conducting a site evaluation, and selecting management practices. Section 3 discusses how site layouts should be designed to reduce water quality impacts.
- **Model Urban Runoff Program Appendix 4T: Post-Construction Controls** (<http://www.coastal.ca.gov/la/docs/murp/4t.pdf>): The appendix to this manual contains a section on treatment controls that describes rooftop treatment systems, vegetated filter strips, vegetated swales, infiltration basins and trenches, detention ponds, retention ponds, constructed wetlands, filtration practices, and oil/grit separators. It also includes a list of additional resources for more information.
- **USEPA, National Management Measures Guidance to Control Nonpoint Source Pollution from Urban Areas** (<http://www.epa.gov/owow/nps/urbanmm/>): Chapter 5 of this manual describes the different types of treatment controls, including design and maintenance considerations, cost, and effectiveness.
- **National Menu of Best Management Practices for Storm Water Phase II, Post-Construction Storm Water Management in New Development and Redevelopment Fact Sheets** (<http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post.cfm>): USEPA's guidance for small

NPDES-regulated municipalities details numerous runoff treatment practices to reduce the volume of and pollutant concentrations in storm water from new development sites.

- **California Department of Transportation (Caltrans), *Statewide Storm Water Quality Practice Guidelines*** (http://www.dot.ca.gov/hq/env/stormwater/special/newsetup/_pdfs/management_ar_rwp/CTSW-RT-02-009.pdf): Section 5 of this manual describes treatment practices that Caltrans has approved (biofiltration swales and strips, infiltration basins, detention devices, traction sand traps, dry weather flow diversion, and linear radial device and inclined screens) and the process by which the practices are selected, sited, sized, designed, and implemented to minimize environmental impact.
- **USEPA, Environmental Technology Verification (ETV) Web site** (<http://www.epa.gov/etv>): The ETV program Web site, sponsored by USEPA and the National Sanitation Foundation, develops testing protocols and verifies the performance of innovative technologies for environmental controls, including storm water treatment practices. It is a good source for determining the relative performance of new proprietary technologies.
- **Caltrans New Technology Report** (http://www.dot.ca.gov/hq/env/stormwater/special/newsetup/_pdfs/new_technology/CTSW-RT-04-069.pdf): This report summarizes and standardizes information on new technologies, including the latest innovations in permanent storm water treatment and control and existing technologies currently in use. The report contains fact sheets describing progress in more than 130 existing full-scale and small-scale pilot studies for new technologies. The categories of practices being tested include adsorption/ion exchange, chemical treatment, disinfection, drain inlet inserts, detention basin outlet improvements, filters, filtration, infiltration trenches with alternative backfill, litter and debris removal, and sedimentation.
- **City of Los Angeles Stormwater Program, *Reference Guide for Stormwater Best Management Practices*** (<http://www.lacity.org/SAN/wpd/index.htm>): This document provides background information on various storm water management practices, along with comprehensive selection matrices, cost information, and target pollutants for each management practice.
- **Los Angeles County Department of Public Works, *Standard Urban Storm Water Mitigation Plan (SUSMP)*** (http://www.ladpw.org/wmd/NPDES/SUSMP_MANUAL.pdf): As required by LA County's Development Planning Model Program, the SUSMP was developed to guide builders, land developers, engineers, planners, and others in the selection of post-construction management practices. The document also provides guidance to assist in gaining municipal approval for urban storm water runoff mitigation plans prior to the issuance of building and grading permits.
- **Computational Hydraulics International, *PCSWMM 2004*** (<http://www.computationalhydraulics.com/Software/PCSWMM/index.html>): This tool is a graphical decision support system used for EPA's SWMM program to better facilitate storm water management modeling. This program helps simplify the complexities of large and small storm water modeling projects and is ideal for solving problems ranging from BMP installations to continuous hydrology. The application can be purchased at the site, and technical support is also available.
- **USEPA *Parking Spaces/Community Places: Finding the Balance through Smart Growth Solutions*** (<http://www.epa.gov/smartgrowth/parking.htm>): This report presents options for managing parking using innovative alternatives involving reduction in oversupply of parking

spaces, managing demand for parking, and developing pricing strategies. The report includes a discussion of the costs of parking and case studies from across the country.

- **Delaware Department of Natural Resources and Environmental Control *Green Technology: The Delaware Urban Runoff Management Approach***
(http://www.dnrec.state.de.us/DNREC2000/Divisions/Soil/Stormwater/New/GT_Stds%20&%20Specs_06-05.pdf): This is a technical manual that reviews impacts of urban runoff on stream ecosystems and riparian zones. The manual presents how green technology management practices can effectively address these impacts and how to properly design the most appropriate management practice. The document includes chapters on construction and testing specifications, design standards and specifications, landscaping standards and specifications, summaries of standards for management practices, and a set of typical details for each type of management practice.
- **Minnesota Pollution Control Agency *Minnesota Stormwater Manual***
(<http://www.pca.state.mn.us/water/stormwater/stormwater-manual.html>): This extensive storm water management manual covers all aspects of incorporating storm water management practices into new and existing development. The report includes chapters on integrating storm water management into site design, better site design techniques, hydrologic/hydraulic/water quality modeling, cold climate impacts on runoff management, sizing criteria, stormwater credits, details on management practices, additional guidance for geologically limited areas (e.g., karst, shallow bedrock, etc.), and case studies from Minnesota. A series of appendices offer more details about management practices, special considerations, and issue papers and research.

2.3.5.4 Case Studies

A study of 43 Wadeable streams in Austin, Texas, showed that several indicators of stream health (EPT [ephemeroptera, plecoptera, and trichoptera] richness and percent EPT abundance) were higher in streams with storm water ponds protecting 60 to 95 percent than in streams with no storm water controls. This trend was only significant in watersheds that were fully developed (greater than 40 percent impervious cover). In watersheds with less than 40 percent impervious cover, storm water ponds had no significant impact on EPT richness or percent EPT abundance. The researchers attributed the lack of effects of storm water ponds to urban development in the reference watersheds and to the nature of the biological index used to gauge stream health, which was not tailored to the specific environmental conditions of the Austin area (Maxted and Scoggins, 2004).

2.3.5.5 References

Maxted, J.R., and Scoggins, M. 2004: *The ecological response of small streams to stormwater and stormwater controls in Austin, Texas USA*. Prepared by the Watershed Management Institute for the United States Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington DC; Cooperative Agreement 9701.

2.3.6 Management Measure 3.2A

Runoff from Construction Sites

Construction Site Erosion and Sediment Control

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Management Measure

1. Reduce erosion and, to the extent practicable, retain sediment on site during and after construction; and
2. Prepare and implement, prior to land disturbance, an effective, approved erosion and sediment control plan or similar administrative document that specifies erosion and sediment control provisions.

2.3.6.1 Programs

Discharges of pollutants from construction activities are for the most part regulated under the NPDES permitting program. Regulated entities include all construction sites with one or more acres of disturbed area. The SWRCB, Division of Water Quality, Storm Water Program Web site (<http://www.swrcb.ca.gov/stormwtr/construction.html>) provides information to permittees to help them meet the requirements of the NPDES regulations.

Discharges of pollutants from construction sites smaller than 1 acre typically are considered nonpoint sources but might also be regulated at the local level. Construction site operators should contact the municipal department for more information about local requirements, including air quality requirements for dust control.

2.3.6.2 Management Practices

Storm Water Pollution Prevention Plan

A storm water pollution prevention plan (SWPPP) describes in detail how a contractor or developer will reduce soil erosion and contain and treat runoff bearing eroded sediments and construction site chemicals. It normally includes the locations and type of pollutants present, as well as practices used on the site for soil stabilization, perimeter control, and runoff treatment, including vegetation practices, structural and nonstructural practices. It also details spill control measures, response actions, and a monitoring program. The SWPPP entails more than filing written documentation. It requires follow-through on the part of both the developer (for implementation) and regulator or permitting agency (for inspection and enforcement). This follow-through can include reviewing and modifying the SWPPP to account for unexpected events that occur after plans have been approved, and adapting to unforeseen conditions on the site. It must also include inspecting and assessing the effectiveness of implemented management practices on storm water quality. In some cases, practices will require maintenance or alternative or additional management practices.

Erosion Control Practices

Erosion control is the first step in reducing sediment pollution from construction sites. There are several opportunities for erosion control, beginning at the planning stages of construction. Clearing and grading should be scheduled during the dry season when storm water runoff is expected to be minimal.

Construction should be undertaken in a phased schedule, in contrast to the traditional practice of grading a site or excavating it all at once. In phased construction, clearing, grading, and building take place at only one part of a site at a time, and new parts of the site are cleared only after the last part is stabilized with permanent erosion controls and revegetated.

Site fingerprinting is a technique that can be used to protect vegetation and reduce erosion. This practice limits clearing to areas that will be used for buildings, roads, and other infrastructure, leaving undisturbed areas that will be vegetated open space in the final plan. Areas that will remain undisturbed need to be marked off and construction equipment and stockpiles must be excluded to protect the existing vegetation and prevent compaction or erosion. The advantages of site fingerprinting are that natural areas are protected and fewer costs for landscaping are incurred. A disadvantage is that equipment will need to be maneuvered around these protected areas, possibly leading to increased labor hours.

The use of chemical additives to stabilize the soil is sometimes recommended to reduce erosion of exposed, unvegetated areas. Polyacrylamide (PAM) is a common polymer for controlling erosion and promoting infiltration on irrigated agricultural lands, and it has been recommended to reduce erosion on urban construction sites and disturbed areas. It decreases soil bulk density, absorbs water, and binds fine-grained soil particles. Caution should be used when applying PAM in ecologically sensitive areas because its toxicity to aquatic life is unknown. For more information about using PAM at construction sites, visit <http://www.epa.gov/ORD/WebPubs/nctuw/Roa-Espinosa.pdf> (Roa-Espinosa et al., 2000). This paper provides a literature review and experimental results of PAM use at construction sites.

After clearing, grading, and building are complete, temporary and permanent erosion controls should be implemented, including seeding, mulching, sodding, and installing erosion control blankets:

- *Seeding* with native grasses can be used to establish permanent erosion control. There are several seeding techniques that can be used, including broadcast seeding, hydroseeding, and drill seeding. Broadcast seeding is the simplest method and involves scattering seeds by hand or mechanically. Hydroseeding involves spraying a slurry of seeds, fertilizer, tackifier, and water onto exposed soils. This method is more expensive but can be more effective at erosion control because the water and fertilizer additives promote fast growth and the tackifier provides immediate stabilization.
- *Mulching* of disturbed soils can be effective at reducing erosion. Materials used include tacked straw and wood chips and are often covered by erosion control blankets or netting. The mulch typically has a short useful life and is only a temporary measure. Mulching alone should be used when permanent seeding is not feasible, such as in arid or winter conditions when vegetative growth is slow or absent.
- Using *sod* permanently and immediately stabilizes an area with a thick vegetative cover and should be used in sensitive areas or where establishing permanent vegetation by seeding would be difficult.
- *Erosion control blankets* or *turf reinforcement mats* (TRMs) protect the soil from scouring due to runoff and can enhance vegetative growth. TRMs can raise the threshold of natural vegetation to

withstand higher hydraulic forces on slopes and streambanks and in channels. They should be used in combination with seeding to achieve permanent results.

- *Wind erosion controls*, which include bales of hay, solid board fences, and snow fences, can be used to keep soil in place. Sprinkling with water can moisten the soil surface, but watering should be done in moderation to prevent a non-storm water discharge.
- Runoff can be intercepted above disturbed sites and conveyed to a permanent channel or storm drain. Conveyance systems may be *earth dikes*, *perimeter dikes/swales*, or *diversions*. A pipe slope drain or pipe drop structure is a temporary pipe placed from the top of a slope to the bottom of the slope to convey concentrated runoff down the slope without causing erosion.
- On long or steep, disturbed, man-made slopes, *benches*, *terraces*, or *ditches* can be constructed at regular intervals, or retaining walls can be erected, to intercept runoff, slow it down, and prevent it from becoming concentrated flow.
- *Linings* for urban runoff conveyance channels can be installed to prevent scouring. The first choice of lining should be grass or sod because it reduces runoff velocities and provides water quality benefits through filtration/infiltration. Also effective are turf reinforcement mats, riprap, concrete, and gabions.
- *Flow control practices* can be installed in channels to reduce runoff velocity. For example, check dams are small temporary dams constructed across a swale or channel and can be used to reduce the velocity of concentrated flow and, therefore, to reduce erosion in a swale or channel.

Sediment Control Practices

The second step in preventing sediment pollution from construction sites is to install devices that trap or filter sediment from runoff. These can include sediment basins and traps, filter fabric fences, inlet protection devices, and stabilized construction entrances.

- *Sediment traps*: These are typically installed in a drainage way or other point of discharge from a disturbed area. They are small impoundments that allow some sediment to settle out of runoff water before it is drained through a rock dam. Temporary diversions in the form of berms or channels can be used to direct runoff to the sediment trap.
- *Sediment basins*: The use of sediment basins is a popular way to retain sediment generated at the site during construction and can be adapted to serve as runoff control after the site is stabilized. A perforated pipe riser (sometimes wrapped in filter fabric) connected to a drain pipe constricts flow and slowly releases impounded water from the bottom of the basin. A recent modification to the standard sediment basin design is the use of a floating skimmer, which slowly drains relatively clear water from the top of the basin. These structures require regular inspection and maintenance to ensure that they are not clogged with debris or sediment.
- *Filter fabric fence*: Filter fabric or silt fences can be used along the perimeter of the disturbed area to filter out sediment as runoff flows through the fabric. Such fences should be used only where there is sheet flow (no concentrated flow), and the maximum drainage area should be one-half acre or less per 100 feet of fence.

- *Fiber rolls* (also known as straw wattles) consisting of straw, mulch, or composted material rolled and bound (sometimes in filter fabric) can be staked on a hillside or other erosion-prone area. Fiber rolls are installed perpendicular to a slope to act as check dams. When properly installed, fiber rolls reduce the velocity of runoff and can provide sediment removal through filtration. Another advantage is that they can be left in place because they consist of natural materials. On construction sites with relatively flat slopes, fiber rolls are often used at the perimeter of the site between the disturbed area and a sidewalk as a perimeter control in lieu of, or in combination with, silt fence.
- *Compost filter berms* are mounds of material, typically recycled wood chips and bark, that are installed at site perimeters or along slopes to act as a check dam and filter pollutant-laden runoff. The berms are designed to filter runoff by absorbing flows into the compost mixture's void space, gradually releasing them into the ground or offsite. They are usually installed at the bottom of a slope, but they also can be installed at the top of the denuded area to prevent clean runoff from entering exposed areas. Berms are typically installed in lieu of silt fence and are sized at 1 foot high and 2 feet wide (Tyler, 2001). Caine (2001) found that flows through a compost filter berm mobilized humic and tannic acids from the organic material present. In areas that are susceptible to BOD or pH changes, compost material should be carefully chosen to ensure that the practice does not contribute to water quality impairments.
- *Storm drain inlet protection*: Sediment should be excluded from storm drains using inlet protection measures to trap sediment before it enters the storm sewer system. Common inlet protection measures include riprap wrapped in chicken wire, cinder blocks filled with gravel, straw wattles wrapped in filter fabric, drop-inlet bags, and other combinations of materials that filter runoff. Inspection and maintenance of these measures is essential to their effectiveness; failure to remove sediments and debris can result in reduced treatment of runoff and flooding due to clogging.
- *Stabilized construction entrances*. Construction entrances should be clearly designated and reinforced with gravel, corrugated metal sheets, or devices specially designed to clear tires of sediment and hold it for later cleanout. This practice of protecting construction entrances can minimize the loss of sediment associated with the equipment and traffic leaving the site.

2.3.6.3 Information Resources

- **California Storm Water Program Web site**
(<http://www.swrcb.ca.gov/stormwtr/construction.html>): This site provides information to permittees to help them meet the requirements of the NPDES regulations. The site includes frequently asked questions, the construction general permit, forms, and tools for searching State databases of permittees.
- **Storm Water Best Management Practice Handbook: Construction**
(<http://www.cabmphandbooks.org/Construction.asp>): *The Construction Handbook* outlines waste management practices in a set of fact sheets that include erosion controls (scheduling, velocity dissipation devices, slope drains, streambank stabilization, polyacrylamide, preservation of existing vegetation, hydraulic mulch, hydroseeding, soil binders, straw mulch, geotextiles and mats, wood mulching, earth dikes, and drainage swales), sediment controls (silt fence, storm drain inlet protection, chemical treatment, sediment basins, sediment traps, check dams, fiber rolls, gravel bag berms, street sweeping and vacuuming, sandbag barriers, straw bale barriers, stabilized construction entrances and exits, stabilized construction roadways, entrance/outlet tire washing), and wind erosion control.

- **Erosion and Sediment Control Field Manual** (<http://store.abag.ca.gov/construction.asp>): This manual from the San Francisco RWQCB describes management practices for construction site planning and management, erosion and sediment control, pollution prevention, and sampling guidelines. Descriptions of practices are concise and include full-color graphics and installation information including guidelines, timing, and limitations. The manual also includes the new Phase II regulations, the SWRCB's sampling and monitoring guidelines, and long-term maintenance information. Also available are several erosion and sediment control videos (in English and Spanish), **Guidelines for Construction Projects**, and a **CD Training Kit** that includes a complete training kit for construction site planning and management for compliance with NPDES requirements, the 1999 version of the *Erosion and Sediment Control Field Manual*, and *Guidelines for Construction Projects*.
- **National Menu of Best Management Practices for Storm Water Phase II, Construction Site Storm Water Runoff Control Fact Sheets** (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm): USEPA's guidance for small NPDES-regulated municipalities details numerous erosion and sediment control techniques to reduce the generation and offsite transport of dust, sediment, and construction site chemicals and materials.
- **Kentucky Erosion Prevention and Sediment Control Field Guide** (http://www.tetratex.com/wstraining/pdf/esc_guide.pdf). This field guide offers succinct, basic information on construction site preparation, project planning, and erosion and sediment control techniques. The guide offers an assessment of various construction site management practices along with photos and graphics discussing the practices.
- **Smart Growth Begins at the Local Level** (<http://www.mwcog.org/planning/planning/smartgrowth/>): This site offers a multimedia video and Web site to inform and educate elected officials, civic groups, the development community, and citizens about the land use and transportation challenges currently facing the region. In addition to the video, the site also offers an overview of smart growth principles, frequently asked questions, links, resources, and news.
- **Caltrans Storm Water Quality Handbooks, Construction Site Best Management Practices Manual, Fiber Rolls** (<http://www.dot.ca.gov/hq/construc/stormwater/SC-05.pdf>): Caltrans' fact sheet describes appropriate applications, limitations, standards and specifications, and maintenance and inspection considerations for fiber rolls. The manual also includes guidance on fiber roll assembly, installation, and removal.
- **City of Watsonville Erosion Control Standards** (<http://www.ci.watsonville.ca.us/publicworks/erocontrols4.pdf>): This document (in PDF format) specifies temporary erosion control measures for the City of Watsonville, California. These control measures, effective during the rainy season (October 15 to April 15), are required to be installed and maintained in accordance with the San Francisco Bay Regional Water Quality Control Board's *Erosion and Sediment Control Field Manual* (this manual is available for purchase at <http://store.abag.ca.gov/construction.asp>).

2.3.6.4 References

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(<http://www.epa.gov/owow/nps/urbanmm>)

2.3.7 Management Measure 3.2B

Runoff from Construction Sites

Construction Site Chemical Control

Fact Sheet Links:

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- Case Studies
- References

Management Measure

1. Limit application, generation, and migration of toxic substances;
2. Ensure the proper storage and disposal of toxic materials;
3. Apply nutrients at rates necessary to establish and maintain vegetation without causing nutrient runoff to surface waters; and
4. Prepare and implement, prior to the use or storage of toxic materials on site, an effective, approved chemical control plan or similar administrative document that contains chemical control provisions (e.g., minimize use of toxic materials; ensure proper containment if toxic materials are to be used/stored on site).

2.3.7.1 Programs

Discharges of pollutants from construction activities are for the most part regulated under the NPDES permitting program. Regulated entities include all construction sites with 1 or more acres of disturbed area. The SWRCB Division of Water Quality, Storm Water Program Web site (<http://www.swrcb.ca.gov/stormwtr/construction.html>) provides information to permittees to help them meet the requirements of the NPDES regulations. Discharges of pollutants from construction sites smaller than 1 acre typically are considered nonpoint sources, but may also be regulated at the local level.

The California Department of Pesticide Regulation regulates the storage and use of all pesticides. The Department's Web site (<http://www.cdpr.ca.gov/>) contains links to information regarding laws and regulations; product use information; licensing and certification programs for applicators, dealers, and advisors; integrated pest management practices (see the School IPM link for health- and environment-conscious pest management practices); and other information related to pesticide use.

2.3.7.2 Management Practices

The practices associated with this management measure focus on properly using chemicals that might be spilled or transported in runoff, which means storing and using chemicals according to the instructions on the label. Users can help to ensure that chemicals will not become pollutants in runoff by providing a covered storage area with primary and secondary containment of chemicals and storage off the ground to prevent accidental spills or leaks. Care should be taken to not use chemicals during wet weather or high wind conditions. Also, less toxic alternatives should be considered.

Pesticides: The following practices should be used to reduce risks associated with pesticides or to reduce the amount of pesticides that come in contact with storm water:

- Follow all federal, State, and local regulations that apply to the use, handling, or disposal of pesticides.

- Do not handle the materials any more than necessary.
- Store pesticides in a dry, covered area.
- Construct curbs or dikes to contain pesticides in case of spillage.
- Follow the recommended application rates and methods.
- Have equipment and absorbent materials available in areas where pesticides are stored and used to contain and clean up any spills that occur.

Petroleum products: The following management practices should be followed to reduce the risk of contamination associated with petroleum products:

- Store petroleum products and fuel for vehicles in covered areas with dikes in place to contain any spills.
- Immediately contain and clean up any spills with absorbent materials.
- Have equipment available in fuel storage areas and in vehicles to contain and clean up any spills that occur.

Solid wastes: State or local solid waste regulatory agencies or private firms should be consulted to ensure the proper disposal of contaminated soils that have been exposed to and still contain hazardous substances. Some landfills might accept contaminated soils, but they require laboratory tests first. The following steps should be taken to ensure proper storage and disposal of solid wastes:

- Designate a waste collection area onsite that does not receive a substantial amount of runoff from upland areas and does not drain directly to a water body.
- Ensure that containers have lids so they can be covered before periods of rain, and keep containers in a covered area whenever possible.
- Schedule waste collection to prevent the containers from overfilling.
- Clean up spills immediately. For hazardous materials, follow cleanup instructions on the package. Use an absorbent material such as sawdust or kitty litter to contain the spill.
- During the demolition phase of construction, provide extra containers and schedule more frequent pickups.
- Collect, remove, and dispose of all construction site wastes at authorized disposal areas. A local environmental agency can be contacted to identify these disposal sites.

Hazardous materials: The following steps should be taken to ensure the proper disposal of hazardous materials:

- Local waste management authorities should be consulted about the requirements for disposing of hazardous materials.

- A hazardous waste container should be emptied and cleaned before it is disposed of to prevent leaks.
- The original product label should never be removed from the container. It contains important safety information. Follow the manufacturer's recommended method of disposal, which should be printed on the label.
- If excess products need to be disposed of, they should never be mixed during disposal unless specifically recommended by the manufacturer.
- Paint and dirt are often removed from surfaces by sandblasting or pressure washing. Sandblasting grits and pressure wash water are the byproducts of these procedures and consist of the sand or water used and the paint and dirt particles that are removed from the surface. These materials can be hazardous if they are removed from older structures because they are more likely to contain lead-, cadmium-, or chrome-based paints. To ensure proper disposal of sandblasting grits and pressure wash water, a licensed waste management or transport and disposal firm should be contracted.

Storage and disposal: The following are ways to ensure proper storage and disposal of materials:

- Cover and stabilize topsoil stockpiles to reapply when revegetating the site.
- Locate pollutant sources such as access roads, borrow areas, and material stockpiles away from critical areas such as steep slopes, highly erodible soils and areas that drain directly into sensitive water bodies.

Phosphorus- and nitrogen-containing fertilizers are used on construction sites to provide nutrients necessary for plant growth, and phosphorus- and nitrogen-containing detergents are found in wash water from vehicle cleaning areas. Excesses of these nutrients can be a major source of water pollution. Management practices to reduce risks of nutrient pollution include the following:

- Apply fertilizers at the minimum rate and to the minimum area needed.
- Work the fertilizer deeply into the soil to reduce exposure of nutrients to storm water runoff.
- Apply fertilizer at lower application rates with a higher application frequency.
- Ensure that erosion and sediment controls are in place to prevent fertilizers and sediments from being transported offsite.
- Use detergents only as recommended, and limit their use on the site. Wash water containing detergents should not be dumped into the storm drain system—it should be directed to a sanitary sewer or be otherwise contained so that it can be treated at a wastewater treatment plant.

2.3.7.3 Information Resources

- ***Storm Water Best Management Practice Handbook: Construction*** (starting on page 279 of <http://www.cabmphandbooks.org/Construction.asp>): This manual, developed for California, deals with construction activities and is specifically geared for construction site operators covered

under the NPDES general permit. It includes fact sheets for many erosion and sediment control and waste/material management practices.

- **The California Department of Pesticide Regulation Web site** (<http://www.cdpr.ca.gov/>): This site contains the School Integrated Pest Management Program page and a series of fact sheets for pesticide use in noncrop settings (published in both English and Spanish), which are accessible at <http://www.cdpr.ca.gov/cfdocs/apps/schoolipm/main.cfm>. These fact sheets include safety requirements for pesticide handlers, pesticide storage, transportation and disposal, use of engineering controls, first aid and decontamination, respiratory protection, worker safety regulations, laundering pesticide contaminated clothing, hazard communication requirements for employees handling pesticides, and minimal exposure pesticides in noncrop settings. Other pesticide resources that can be helpful include the following:
 - **Lawn Care Tips** (<http://www.cdpr.ca.gov/docs/factshts/lawn15.pdf>)
 - **Pesticides and Proposition 65** (<http://www.cdpr.ca.gov/docs/factshts/prop65.htm>)
 - **Consumer Products Treated with Pesticides** (<http://www.epa.gov/pesticides/factsheets/treatart.htm>): The presence of microorganisms (bacteria, fungi, and viruses) in or on various items has become of increased concern to consumers. In response to these concerns, many products (e.g., cutting boards, kitchen sponges, cat litter, toothbrushes, and juvenile toys) are being treated with antimicrobial pesticides. Antimicrobial pesticides are substances or mixtures of substances used to destroy or limit the growth of microorganisms, whether bacteria, viruses, or fungi—many of which are harmful—on inanimate objects and surfaces.
 - **Pesticide Storage and Disposal** (<http://www.cdpr.ca.gov/docs/factshts/storage.pdf>) [Spanish (<http://www.cdpr.ca.gov/docs/factshts/storage-s.pdf>)]

2.3.8 Management Measure 3.3A Runoff from Existing Development Existing Development

Fact Sheet Links:

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- [Case Studies](#)
- [References](#)

Management Measure

Develop and implement watershed management programs to reduce runoff pollutant concentrations and volumes from existing development:

1. Identify priority local and/or regional watershed pollutant reduction opportunities (e.g., improve existing urban runoff control structures);
2. Specify a schedule for implementing appropriate controls;
3. Limit destruction of natural conveyance systems; and
4. Where appropriate, preserve, enhance, or establish buffers along surface waters and their tributaries.

2.3.8.1 Programs

The California Department of Transportation (Caltrans) is conducting a series of Retrofit Pilot Studies for modifying existing infrastructure such as facilities and highways to address water quality. A number of different management practices are being studied, including biofiltration, infiltration basins and trenches, catch basin inserts, detention basins, and media filters (http://www.dot.ca.gov/hq/env/stormwater/ongoing/pilot_studies/index.htm).

The Model Urban Runoff Program was developed by the City of Monterey, in conjunction with the City of Santa Cruz, Monterey Bay National Marine Sanctuary, California Coastal Commission, Association of Monterey Bay Area Governments (AMBAG), and Woodward-Clyde Consultants. The program provides guidance to small municipalities that need to meet NPDES Phase II requirements (<http://www.swrcb.ca.gov/stormwtr/murp.html>).

The Watershed Information Technical System (WITS), developed by the California Environmental Resources Evaluation System (CERES), is a program that provides the information and tools to support local watershed planning, restoration, monitoring, and education. CERES and WITS are programs of the California Resources Agency (<http://ceres.ca.gov/watershed/>).

The Urban Creeks Council of California works to protect and restore waterways in urban areas through shoreline stabilization, the establishment and protection of buffers and riparian zones, and educational programs for the general public (<http://www.urbancreeks.org/>).

The County of San Diego's Project Clean Water is a watershed-based approach to integrating regional efforts at improving water quality. The project includes the development of technical guidance for watershed-based urban runoff programs, education and outreach, and the development of a repository for water quality information in the region (<http://www.projectcleanwater.org/index.html>).

2.3.8.2 Management Practices

Watershed management programs facilitate the prioritization of NPS pollutants and the development of implementation strategies for mitigating the effects of those priority pollutants. By addressing NPS pollution on a watershed basis, managers can ensure that retrofit projects are consistent with overall water quality goals. Watershed management programs for existing development can be used to achieve these three objectives:

- Reduction of pollutant loads from storm water runoff
- Reduction of the volume of storm water runoff, particularly to reduce erosion on streambanks and conveyance systems
- Implementation of nonstructural controls such as the preservation and enhancement of natural buffers along water bodies

There are a number of structural practices that address runoff volume and pollutant loads in urban storm water. In developed areas, however, space is often limited, requiring that retrofit opportunities and nonstructural practices be employed. Retrofitting involves modifying existing runoff structures by enlargement, modification of inflow and outflow characteristics, and increasing detention time to remove sediment and other pollutants.

The following are structural practices (including retrofits) suitable for urban areas:

- Devices that fit into the storm water conveyance system, such as sand filters, trash racks, and water quality inlets
- Modification of existing storm water ponds, drainage pipe outfalls, and the upstream end of road culverts
- Infiltration practices in or near parking lots (bioretention, porous pavement, sand filters and underground vaults)

Once applicable management practices are identified, areas within each watershed can be prioritized for implementation based on site characteristics such as location, ownership, drainage area, soils, and other conditions that may be applicable to specific management practices. These site assessments are conducted using existing data, such as aerial photographs, zoning maps and GIS data, and field surveys.

Where possible, modification of natural drainage patterns should be avoided. Increasing impervious areas by paving and curbing contributes to water quality degradation by increasing peak flows and preventing the natural storm water treatment functions performed by vegetated areas. It is beneficial to route storm water over vegetated buffers, infiltration devices, or other pervious areas. Converting channelized storm water to sheet flow thus increasing its flow path allows these natural infiltration techniques to function properly and remove pollutants. Another option is using open vegetated swales in place of conventional conveyance devices.

In addition to identifying, prioritizing, and implementing management practices for controlling runoff volume and pollution, water quality in urban areas can be protected by restoring streams, preserving buffers, and stabilizing streambanks. Stream restoration involves reestablishing instream habitat structure and riparian cover, stabilizing channel morphology, protecting critical stream substrates, and mitigating the cause of degradation, if possible. Buffers along streams should be preserved and restored, and streambank stabilization techniques can help reduce erosion and provide habitat.

Nonstructural practices are also well suited for developed areas, because they help to control pollution at its source. Techniques that disconnect runoff from conveyance systems (e.g., rain barrels) and urban forestry practices can serve as nonstructural retrofits. Other nonstructural practices applicable to existing development include education and outreach programs, the establishment and preservation of buffers along water bodies, and ordinances to preserve pervious areas within developed areas. Green space goals can be set to promote tree plantings and pavement reclamation projects.

2.3.8.3 Information Resources

Structural Practices and Retrofits

- **U.S. Department of Transportation, Federal Highway Administration, *Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring*** (<http://www.fhwa.dot.gov/environment/ultraurb/index.htm>): This online manual provides guidance on storm water management in developed urban areas that have limited space for treatment practices. The intent is to promote technology that is cost-effective and low-maintenance for the ultra-urban environment.
- **USEPA, National Menu of Best Management Practices, Post-Construction Storm Water Management Fact Sheets** (<http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/post.cfm>): These fact sheets provide guidance on a number of management practices applicable to existing development.
- **County of San Diego's Project Clean Water, *Existing Residential Areas Model Program Guidance*** ([http://www.projectcleanwater.org/pdf/Model Program - Residential Areas.PDF](http://www.projectcleanwater.org/pdf/Model%20Program%20-%20Residential%20Areas.PDF)): This document outlines a number of management practices appropriate for existing residential development, as well as an implementation strategy.
- **NOAA, *Alternatives for Coastal Development, One Site, Three Scenarios*** (<http://www.csc.noaa.gov/alternatives/>): This Web site illustrates three different development scenarios created for a residential area in coastal Georgia. The analysis calculates and compares economic, environmental, and social indicators. Environmental factors considered in the analysis include vegetated buffers, impervious surface, and pollutant runoff.
- ***The National Stormwater Quality Database*, Pitt et al.** (<http://unix.eng.ua.edu/~rpitt/Research/ms4/Paper/Mainms4paper.html>): This paper presents preliminary findings of a USEPA-sponsored project to assemble and analyze monitoring data collected over nearly a ten-year period from more than 200 municipalities throughout the country. In addition to the analysis, the project will provide recommendations for improving future NPDES monitoring efforts. Some of the issues that are being examined with these data include the occurrence and magnitude of first-flushes, the effects of different sampling methods on stormwater quality data, trends in stormwater quality over time, the effects of infrequent wrong data in large databases, appropriate methods to handle values that are below detection limits, and the necessary sampling effort needed to characterize stormwater quality. Related articles are also available at this site.

Nonstructural Practices

- **Northern Virginia Regional Commission, *Nonstructural Urban BMP Handbook*** (<http://www.novaregion.org/bmp.htm>): This manual provides watershed managers, planners, and engineers with guidance on the implementation of nonstructural practices.

- **Low Impact Development Center Web site** (<http://www.lowimpactdevelopment.org/>): This resource contains technical references for implementing low impact development techniques and has case studies of sites where these practices have been successfully implemented.
- ***Second Nature: Adapting LA's Landscape for Sustainable Living***: This manual examines designs for retrofitting five urban sites to help address problems such as water pollution, water and energy use, flood management, and waste reduction. The manual focuses on converting Los Angeles' landscape to reduce water pollution and can be useful to provide innovative, expensive practices in other cities. The guide can be purchased online at <http://www.treepeople.org/vfp.dll?OakTree~getPage~&PNPK=21>.
- **Delaware Coast-A-Syst Program and Booklet** (<http://www.dnrec.state.de.us/dnrec2000/Divisions/Soil/dcmp/asyst.htm>): Coast-A-Syst, the Coastal Homestead Assessment System, is a program designed to help homeowners protect the quality of surface and ground waters near their homes. A guidance booklet is provided that consists of information that will enable homeowners to identify and correct pollution sources and health risks in their homes and around their yards. Ultimately, the Coast-A-Syst program can help to identify pollution risks before expensive or dangerous problems occur.

Urban Stream Restoration and Buffers

- **California Department of Water Resources, Planning and Local Assistance, Urban Stream Restoration Program** (<http://www.watershedrestoration.water.ca.gov/urbanstreams>): This program provides funding for projects to assist communities in reducing damages from streambank and watershed instability and floods while restoring the environmental and aesthetic values of streams. The Web site offers an overview of past projects funded by the program as well as guidelines for project proposals.
- **Stormwater Manager's Resource Center** (<http://www.stormwatercenter.net/>): The Stormwater Manager's Resource Center provides resources for those involved in local storm water management. These resources include several resources pertaining to aquatic buffers and restoration practices.
- **USEPA, Model Ordinance for Aquatic Buffers** (<http://www.epa.gov/owow/nps/ordinance/mol1.htm>): This model ordinance can serve as a guide for municipalities looking to establish stream buffers.
- **Ann Riley, *Urban Stream Restoration: A Video Tour of Ecological Restoration Techniques*** (<http://www.noltemedia.com/nm/urbanstream/>): This video, which is 61 minutes long and can be ordered online, is a documentary tour of six urban stream restoration sites. It provides background information on funding, community involvement, and the history and principles of restoration. The demonstration includes examples of stream restoration in very urbanized areas, re-creating stream shapes and meanders, creek daylighting, soil bioengineering, and ecological flood control projects.
- **Ohio Department of Natural Resources, Stream Management Guide Fact Sheets** (http://www.dnr.state.oh.us/water/pubs/fs_st/streamfs.htm): This is a compilation of fact sheets on technical guidance for streambank and instream practices, general stream management, and stream processes.
- **Federal Interagency Stream Restoration Working Group, *Stream Corridor Restoration: Principles, Processes and Practices*** (http://www.nrcs.usda.gov/technical/stream_restoration/):

This document provides background information on stream corridors, the development of stream corridor restoration plans, and details on restoration practices.

- **USDA NRCS, Watershed Technology Electronic Catalog** (<http://www.wcc.nrcs.usda.gov/wtec/wtec.html>): This online catalog is a source of technical guidance on a variety of restoration techniques and management practices, to provide direction for watershed managers and restoration practitioners. The site is focused on providing images and conceptual diagrams.
- **USDA NRCS, Buffer Strips: Common Sense Conservation** (<http://www.nrcs.usda.gov/feature/buffers/>): This Web site provides background information on the benefits of buffers, technical guidance, and examples of successful buffer implementation.

Urban Forestry

- **The Center for Watershed Protection (CWP), Urban Watershed Forestry Manual** (<http://www.cwp.org/forestry/index.htm>): The Center for Watershed Protection (CWP), in cooperation with the USDA Forest Service, Northeastern Area State and Private Forestry Branch, is producing a three-part manual series on using trees to protect and restore urban watersheds. This manual provides information on methods for increasing forest cover in a watershed; specific ways to enable developers, engineers, or landscape architects to incorporate more trees into a development site; and detailed guidance on urban tree planting at both the development site and the watershed scale. Parts 1 and 2 of the manual are available for download at this Web site.

Monitoring Documents

- **California Department of Transportation, Guidance Manual: Stormwater Monitoring Protocols, Second Edition** (http://www.dot.ca.gov/hq/env/stormwater/special/guidance_manual/index.htm): This manual covers the entire process of storm water monitoring, with sections that describe the following topics: purpose and objectives; site, constituent, and monitoring method and equipment selection; sampling and analysis plan development; installation and maintenance of equipment; training; logistics; sample collection; quality assurance/quality control (QA/QC); preparation of laboratory samples and analytical methods, QA/QC data evaluation, and data reporting protocols.

2.3.8.4 Case Studies

Santa Monica Bay Restoration Project. The purpose of this project was to evaluate the feasibility and effectiveness of catch basin inserts in addressing storm water pollutant loads into Santa Monica Bay. The devices cost less than \$1,000 per catch basin and required an average maintenance frequency of once annually. The three components of the project were

- Characterization of local storm water runoff and selecting target pollutants
- Evaluating catch basin retrofits
- Conducting feasibility and cost-benefit analysis for inter-city retrofit scenarios

This project laid the framework for the development of decision frameworks for municipalities looking to develop retrofit programs. The framework, in the form of a decision tree, helps planners select devices based on local conditions, feasibility, effectiveness, cost and maintenance requirements (<http://www.epa.gov/owow/estuaries/coastlines/99janfeb.pdf>).

BMP House Demonstration Project. The City of Los Angeles and TreePeople conducted a demonstration project that involved retrofitting a single-family home with multiple management practices. This included a Cistern Collection System, Vegetated/ Mulched Swale, Retention Grading, and Driveway Dry Well (<http://www.lacity.org/SAN/wpd/index.htm>).

Seattle Street Edge Alternatives (SEA Streets) Project. The City of Seattle Washington implemented alternative urban landscape designs in an existing neighborhood to create a system of drainage that more closely mimics the natural landscape prior to development than traditional piped systems. By reducing impervious surfaces to 11 percent less than a traditional street, providing surface detention in swales, and adding trees and shrubs, the neighborhood was able to reduce storm water runoff by 98 percent (http://www.ci.seattle.wa.us/util/About_SPU/Drainage_&_Sewer_System/Natural_Drainage_Systems/Street_Edge_Alternatives/index.asp).

2.3.8.5 References

USEPA. 2005. *National Management Measures to Control Nonpoint Source Pollution from Urban Areas*. EPA 841-B-05-004. U.S. Environmental Protection Agency, Washington, DC.
(<http://www.epa.gov/owow/nps/urbanmm>)

2.3.9 Management Measure 3.4A

Onsite Wastewater Treatment Systems (OWTSs)

New OWTSs

Fact Sheet Links:

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- [Case Studies](#)
- [References](#)

Management Measure

1. Ensure that new OWTSs are located, designed, installed, operated, inspected, and maintained to prevent the discharge of pollutants to the surface of the ground and, to the extent practicable, reduce the discharge of pollutants into ground water. Where necessary to meet these objectives:
 - a. Discourage the installation of garbage disposals to reduce hydraulic and nutrient loadings;
 - b. Install low-volume plumbing fixtures in new developments or redevelopments as required by State law; and
 - c. Encourage installation of low-volume plumbing fixtures in existing developments. Implement OWTS inspection schedules for pre-construction, construction, and post-construction.
2. Direct placement of OWTSs away from unsuitable areas. Where OWTS placement away from unsuitable areas is not practicable, ensure that the OWTS is designed or sited at a density so as not to adversely affect surface waters or ground water. Unsuitable sites include areas
 - a. With poorly or excessively drained soils;
 - b. With shallow water tables or high seasonal water tables;
 - c. Within floodplains; or
 - d. Where nutrient and/or pathogen concentrations in the effluent cannot be sufficiently treated or reduced before the effluent reaches sensitive water bodies.
3. Establish protective setbacks from surface waters, wetlands, and floodplains for conventional as well as alternative OWTSs. The lateral setbacks should be based on soil type, slope, hydrologic factors, and type of OWTS. Where uniform protective setbacks cannot be achieved, site development with OWTSs so as not to adversely affect water bodies or contribute to a public health nuisance.
4. Establish protective separation distances between OWTS system components and ground water. The separation distances should be based on soil type, distance to ground water, hydrologic factors, and type of OWTS.
5. Where conditions indicate that nitrogen-limited surface waters may be adversely affected by excess nitrogen loadings from ground water, prohibit the installation of OWTSs or require the installation of OWTSs that reduce total nitrogen loadings.

2.3.9.1 Introduction

In many cases, when new areas are being developed in rural or urban fringe settings, treatment of sewage is performed onsite at the point of origin (home or business). This type of sewage treatment is particularly needed in areas where development density is low, causing sewerage projects to be prohibitively expensive compared with the number of customers served. Systems for storing and treating small residential and commercial waste streams are called onsite wastewater treatment systems, or OWTs. OWTs typically consist of a septic tank for storage and a subsurface soil absorption field (USEPA, 2005).

Buried in the ground, septic tanks are essentially watertight, single- or multiple-chamber sedimentation and anaerobic digestion tanks that treat wastewater flowing through them. They are designed to receive and pretreat domestic wastewater, mediate peak flows, and keep settleable solids, oils, scum, and other floatable material out of the soil absorption field. Wastewater effluent is discharged from the tank and to a series of underground perforated pipes or perforated pipe wrapped in synthetic material. From there, the partially treated effluent flows onto and through the soil. Treatment occurs in the septic tank and within the biomat that forms at the soil infiltrative surface. The treated effluent also receives some treatment as it moves through the underlying soil profiles. Treated effluent that is not drawn into plant roots, incorporated into microbial biomass, or evaporated ultimately reaches ground water and/or surface waters.

Supplemental treatment systems (also known as alternative or innovative systems) such as mound systems, fixed-film contact units, wetlands, aerobic treatment units, and low-pressure drip applications, are used in areas where conventional soil-based systems cannot provide adequate treatment of wastewater effluent due to site constraints (USEPA, 2005). Areas that might not be suitable for conventional systems are those with nearby nutrient-sensitive waters, high densities of existing conventional systems, highly permeable or shallow soils, shallow water tables, large rocks or confining layers, and poorly drained soils. Supplemental systems feature components and processes designed to promote degradation and/or treatment of wastes through biological processes, oxidation/reduction reactions, filtration, evapotranspiration, and other processes. Cluster systems are also used to collect and treat wastewater from multiple facilities. In these systems, wastewater is collected from several locations and passed through a treatment unit (septic tank, lagoon, wetland or other supplemental treatment system) and is released to subsurface soils at a common site. Cluster systems often require individual septic tanks for each facility or home served to provide primary treatment and minimize fat, oil, grease, and solids loading to cluster system treatment unit. (Note: Cluster systems that serve 20 or more people may be regulated by a federal, State, and/or local Underground Injection Control Program for Class V facilities. For more information, see <http://www.epa.gov/safewater/uic.html>.)

2.3.9.2 Programs

The California Wastewater Training and Research Center (CWTRC) conducts research and provides training and education on management practices for wastewater treatment. The Center's Web site contains technical guidance documents and articles, links to important local, State, and federal programs, and information on training opportunities (<http://www.csuchico.edu/cwtrc/>).

The California Onsite Wastewater Association (COWA) is an association of industry professional that work in the OWTs field. The COWA Web site provides links to relevant information for engineers and government agencies, as well as links to county health departments (<http://www.cowa.org/>).

County health departments generally regulate OWTs, but Regional Boards also have the authority to regulate them. Note that OWTs are prohibited in some areas, such as where receiving waters are nutrient

or pathogen sensitive, where there is a high density of existing OWTs, or where geologic conditions prevent adequate treatment of sewage. Check with your county government to determine what types of systems are allowed in your area.

2.3.9.3 Management Practices

Management practices for new OWTs are focused on permitting and installation. These practices fall into the following four categories:

- Comprehensive planning by the regulatory authority, including measures to protect sensitive areas, such as nutrient-limited waters and shellfish harvest areas. Measures might include prohibitions, setbacks, or requirements for the use of innovative treatment systems to effect greater treatment of sewage.
- Performance-based requirements for the siting, design, and installation of systems
- Training and certification programs
- Inspection of newly installed systems

The first practice is the development a comprehensive plan that establishes and implements OWTs water quality planning processes, and coordinates with the overall land use planning process with that water quality planning process. By coordinating water quality planning with land use planning, responsible agencies can more easily address the protection of sensitive areas. Also, responsible agencies can establish basic guidelines on issues regarding where conventional or alternative systems will be allowed, maximum OWTs densities, and consideration of alternative solutions such as the extension of sewer lines for developing areas (USEPA, 2005, 2002).

Specific requirements should be developed for the selection, siting, design, and installation of OWTs. There are four components to this measure (USEPA, 2005):

1. Develop performance-based programs with specific goals and criteria that address public health and water quality;
2. Model system performance to determine the long-term impacts of OWTs on water resources;
3. Develop criteria for siting OWTs, such as setback guidelines and official maps showing areas where conditions are suitable for installation, including the following:
 - Wastewater characterization and expected effluent volumes;
 - Site conditions (e.g., soils, geology, ground water, surface waters, topography, structures, property lines);
 - System capacity, based on estimated peak and average daily flows;
 - Location of tanks and appurtenances;
 - Tank dimensions and construction materials;
 - Supplemental treatment units and configuration;
 - Required absorption field dimensions and materials;
 - Requirements for alternative soil absorption field areas,

- Sizing and other acceptable features of system piping;
 - Separation distances from other site features;
 - Operation and maintenance requirements (access risers, safety considerations, inspection points); and
 - Monitoring requirements (USEPA, 2002); and
4. Develop site evaluation procedures to assess site suitability. Evaluation techniques are based on soils, hydrogeology, or multiple factors, such as soils, climate, ground water, OWTS densities, and distance to water resources. The following are procedures for site evaluation (USEPA, 2005; ASTM, 1995; ASTM, 1996):
- Preliminary documentation (site survey maps, soil surveys, aerial photos, regulations and setbacks, loading rates)
 - Identification of unsuitable areas (water supply separation distances, buffer zones and setbacks, limiting physiographic features)
 - Subsurface investigations (depth to ground water, soil profiles, percolation tests)
 - Identification of recommended OWTS site (data integration, selection of preferred areas, gravity-based flow assessment, final selection).

The third practice addresses the need for qualified professional personnel to oversee OWTS design, construction, maintenance, and monitoring. This can be performed through education, training, licensing and/or certifications for site evaluators, installers, designers, and inspectors. Certification and licensing of service providers can help ensure program effectiveness and compliance and reduce administrative burdens. Professional programs are typically the mechanism for certification, and include required coursework or training; an assessment of knowledge, skills, and professional judgment; past experience; and demonstrated competency. Most licensing programs also require attendance at continuing education workshops (USEPA, 2002).

Finally, the OWTS should be inspected at various stages during and after installation. A post-construction inspection program should ensure that systems were installed properly, design specifications were followed, and soil absorption field areas were not compacted during construction. Inspections can be conducted by management personnel or trained/certified inspectors (USEPA, 2005, 1993). If necessary, repairs, replacements, or upgrades should be made to septic systems to meet performance requirements.

2.3.9.4 Information Resources

Selection of Treatment Technologies

- **National Small Flows Clearinghouse, Environmental Technology Initiative (ETI) Fact Sheets** (http://www.nesc.wvu.edu/nsfc/nsfc_etifactsheets.htm): The ETI fact sheets describe innovative and alternative onsite wastewater treatment technologies for single families, clusters of homes, subdivisions, and communities. For each technology, general and technical fact sheets are available. The fact sheets were created as part of USEPA's Environmental Technology Initiative.
- **WATERSHEDSS: Water, Soil and Hydro-Environmental Decision Support System, Septic Systems** (<http://www.water.ncsu.edu/watershedss/dss/wetland/aqlife/septic.html - mm>): This fact sheet describes management practices for OWTS, including alternative treatment technologies

such as denitrification systems and regulatory practices such as restrictions on garbage disposals and chemical additives.

- **USEPA, Technology Fact Sheets** (<http://cfpub.epa.gov/owm/septic/technology.cfm>): This Web site provides links to technology fact sheets that cover advantages and disadvantages, design criteria, performance, costs, examples of installations, and references for various onsite wastewater treatment technologies. The site also provides links to non-USEPA fact sheets and the Environmental Technology Verification Program. Many of the fact sheets are available in both English and Spanish.

System Siting, and Design and Management

- **USEPA, Design Manual: Onsite Wastewater Treatment and Disposal Systems** (<http://www.epa.gov/ORD/NRMRL/pubs/625R00008/html/625R00008.htm>): This document, published in 1980, is a technical resource for basic OWTSS. Recently, USEPA released an update to this document, the *Onsite Wastewater Treatment Systems Manual*, with supplementary information and a discussion of new technologies. USEPA recommends that the documents be used together.
- **USEPA, Onsite Wastewater Treatment Systems Manual.** ([http://www.epa.gov/ORD/NRMRL/Pubs/625R00008/625R00008.htm - links](http://www.epa.gov/ORD/NRMRL/Pubs/625R00008/625R00008.htm-links)): This document is an update and companion to the 1980 *Design Manual*. It contains supplementary information on management techniques and recent technological developments.
- **Michael T. Hoover, Ph.D. A Framework for Site Evaluation, Design, and Engineering of On-Site Technologies Within a Management Context** (<http://www.state.ma.us/dep/brp/www/files/hoovered.doc>): This document was written as part of a statewide effort to incorporate watershed-specific performance standards into the Massachusetts onsite wastewater management program. It outlines options for various technologies, siting and design considerations, cost information, and management techniques for decentralized OWTSS.
- **County of San Diego, Land Use Program Guidelines** (http://www.sdcounty.ca.gov/deh/lwq/land_use/guideline.html): This Web site contains a number of guidance documents pertaining to the siting, design, and maintenance of OWTSS as regulated in San Diego.

Training and Certification Programs

- **California State University Office of Water Programs** (<http://www.owp.csus.edu/training.htm>): The Office of Water Programs at the California State University, Sacramento, College of Engineering and Computer Science offers training on the operation and maintenance of wastewater facilities. Documentation and videos as well as distance learning courses are available.
- **NSF International, Onsite Wastewater Inspector Accreditation Program** (http://www.nsf.org/business/wastewater_inspectors/index.asp?program=WastewaterInspectors): This onsite wastewater inspector accreditation program consists of written and field tests, an ethics statement, and continuing education components.
- **California Wastewater Training and Research Center** (<http://www.csuchico.edu/cwtrc/index.html>): The Center conducts training and workshops on wastewater treatment, including OWTSS.

2.3.9.5 Case Studies

Hunters Point Shipyard Decentralized Wastewater Treatment. This study, conducted by the San Francisco Public Utilities Commission, examined the applicability, costs, benefits, and limitations of various alternative treatment approaches. Onsite treatment systems investigated included conventional single and clustered systems, as well as a small satellite treatment facility. The project also involved public outreach and the development of technical resources

(http://sfwater.org/detail.cfm/MSC_ID/84/MTO_ID/NULL/MC_ID/7/C_ID/1588/holdSession/1).

University of Rhode Island Onsite Wastewater Training Center. The Center conducts demonstrations of onsite treatment technology, educates and trains both homeowners and wastewater industry personnel, and provides assistance to municipalities in the development of onsite wastewater management programs (http://www.epa.gov/nps/Section319III/inform_ri.htm).

2.3.9.6 References

American Society for Testing and Materials (ASTM). 1995. *Standard Practice for Surface Site Characterization for On-Site Septic Systems*. Practice D5879-95e1. American Society for Testing and Materials, Conshohocken, PA.

American Society for Testing and Materials (ASTM). 1996. *Standard Practice for Subsurface Site Characterization of Test Pits for On-Site Septic Systems*. Practice D5921-96e1. American Society for Testing and Materials, Conshohocken, PA.

USEPA. 1993. *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. EPA 840-B-92-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC. (<http://www.epa.gov/owow/nps/MMGI/index.html>)

USEPA. 2002. *Onsite Wastewater Treatment Systems Manual*. EPA/625/R-00/008. U.S. Environmental Protection Agency, Office of Water, Washington, DC. (<http://www.epa.gov/ORD/NRMRL/Pubs/625R00008/html/625R00008.htm>)

USEPA. 2005. *National Management Measures to Control Nonpoint Source Pollution from Urban Areas*. EPA 841-B-05-004. U.S. Environmental Protection Agency, Washington, DC. (<http://www.epa.gov/owow/nps/urbanmm>)

2.3.10 Management Measure 3.4B Onsite Wastewater Treatment Systems (OWTSs) Operating OWTSs

Fact Sheet Links:

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- [Case Studies](#)
- [References](#)

Management Measure

Establish and implement policies and systems to ensure that existing OWTSs are operated and maintained to prevent the discharge of pollutants to the surface of the ground and, to the extent practicable, reduce the discharge of pollutants into ground water. Where necessary to meet these objectives, encourage the reduced use of garbage disposals, encourage the use of low-volume plumbing fixtures, and reduce total phosphorus loadings to the OWTS by 15 percent (if the use of low-level phosphate detergents has not been required or widely adopted by OWTS users). Establish and implement policies that require an OWTS to be repaired, replaced, or modified when the OWTS fails or threatens or impairs surface waters.

Inspect OWTSs at a frequency adequate to ascertain whether the OWTSs are failing.

Consider replacing or upgrading OWTSs to treat influent so that total nitrogen loadings in the effluent are reduced to meet water quality objectives. This provision applies only where (a) conditions indicate that nitrogen-limited surface waters may be adversely affected by significant ground water nitrogen loadings from an OWTS, and (b) nitrogen loadings from OWTSs are delivered to ground water.

This management measure deals with the programmatic aspects of OWTS management. The goals are to ensure that systems that are installed as designed are inspected and maintained regularly to prevent failures. Public education about proper sewage treatment system use and maintenance is an important part of this measure, as is development and enforcement of policies to prevent or minimize the impacts of OWTS failures.

2.3.10.1 Programs

County health departments generally regulate OWTSs, but Regional Boards also have the authority to regulate them. Note that OWTSs are prohibited in some areas, such as where receiving waters are nutrient or pathogen sensitive, where there is a high density of existing OWTSs, or where geologic conditions prevent adequate treatment of sewage. Check with your county government to determine what types of systems are allowed in your area. Below are several examples of municipal programs in California.

- The Stinson Beach County Water District's Onsite Wastewater Management Program, established in 1978, manages the permitting and inspection of onsite wastewater treatment systems and conducts water quality monitoring. The County Water District is responsible for the introduction of special treatment systems designed specifically to address problems with water tables and poor percolation rates (<http://stinson-beach-cwd.dst.ca.us/guide/hog1.html>).
- The Marin County Septic Systems Program evaluates and permits onsite sewage systems, as well as gray water systems and septage haulers. The program's Web site contains procedures for conducting performance inspections, fee schedules, background information on septic systems, links to articles with maintenance information for homeowners, and relevant regulations (http://www.co.marin.ca.us/depts/CD/main/comdev/ehs/septic/septic_systems.cfm).

- The Town of Paradise established the Onsite Wastewater Management Zone (OWMZ) in Butte County, California, in 1992 to issue permits for new septic systems and for repairs of operating systems. Trained service providers conduct inspections and maintenance activities. The program is financed by operating permit fees, which are reported to be under \$15 a year and are included in water bills. (<http://pasture.ecn.purdue.edu/~epados/septics/septic/manage.htm> - Town of Paradise, California).

2.3.10.2 Management Practices

The key to managing existing onsite wastewater treatment systems is an effective operation and maintenance program. Operation and maintenance programs should include system inventories; management, operation, and maintenance policies; inspection and monitoring requirements; guidelines for the treatment or reuse of residuals; and public education.

Inventories of existing onsite wastewater treatment systems are an important step in developing an operation and maintenance program. To the extent possible, information on the location, type, date of installation, date of last service, and owner contact information should be maintained. This may require cooperative agreements between agencies.

Management programs can be implemented by regulatory agencies, wastewater utilities or districts, or as voluntary programs. The specific approach should reflect the needs and available resources of the community. USEPA's *Voluntary National Guidelines for the Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems*

(<http://www.epa.gov/owm/mtb/decent/download/guidelines.pdf>) describes in greater detail the various aspects of a management program, and includes case studies, technology fact sheets, and other resources.

Inspection and maintenance programs are useful to help catch systems that are performing poorly. They can be administered through a training program for homeowners, contracts with certified operators, or the management entity itself. System performance can be determined by visual, bacteriological, physical, chemical, and remote monitoring assessment techniques. An effective inspection, monitoring, operation, and maintenance program includes the following (USEPA, 2002):

- Specified intervals for required inspections (e.g., every 3 months, every 2 years, or at the time of property transfer or change of use)
- Legal authority to access system components for inspections, monitoring, and maintenance
- Monitoring of overall operation and performance, including remote sensing and failure reporting for highly mechanical and complex systems
- Monitoring of receiving environments at compliance boundaries to meet performance requirements
- Review of system use or flow records, (e.g., water meter readings)
- Required type and frequency of maintenance for each technology
- Identification, location, and analysis of system failures
- Correction schedules for failed systems through retrofits or upgrades
- Record keeping on systems inspected, results, and recommendations

In addition to ensuring the proper functioning of the system components, the effectiveness of the system as a whole can be improved through water conservation and pollutant reduction practices. This can be

achieved through regulations or public education programs that discourage or prohibit the use of garbage disposals and the disposal of phosphate-containing detergents and household cleaners.

Guidelines for the disposal of residuals are necessary to ensure proper handling and disposal of sludge (septage) removed from septic tanks. Septage is usually managed via land application, treatment at a wastewater treatment plant, or treatment at a special septage treatment plant. State and local septage management programs that incorporate land application or burial of septage must comply with Title 40 of the U.S. Code of Federal Regulations (CFR), Parts 503 and 257. USEPA has published specific guidance on these topics (*Process Design Manual: Land Application of Sewage Sludge and Domestic Septage*, <http://www.epa.gov/ORD/WebPubs/landapp.pdf>).

Finally, public education and outreach are important to improve homeowner and industry awareness of the importance of operation and maintenance procedures. Databases with septic system inventories can be used to distribute maintenance information to homeowners. Typical public outreach and education programs address the benefits of the onsite management program, water conservation, and household and commercial/industrial hazardous waste discharge prevention (USEPA, 2002).

2.3.10.3 Information Resources

General Resources

- **Stormwater Manager's Resource Center, Septic System Controls** (http://www.stormwatercenter.net/Pollution_Prevention_Factsheets/SepticSystemControls.htm). This fact sheet describes ways to develop a comprehensive management program to reduce pollution from septic systems using public outreach and education, regulatory techniques, and maintenance programs.
- **USEPA, *Voluntary National Guidelines for the Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems*** (<http://www.epa.gov/owm/mtb/decent/download/guidelines.pdf>): Released in March 2003, these guidelines are geared toward state, tribal, and local government officials dealing with the management of onsite wastewater treatment systems. They outline the components of a successful management program, including public education, design, site evaluation, operation and maintenance, inspector certification, and funding.
- **USEPA, *Draft Handbook for the Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems*** (<http://cfpub.epa.gov/owm/septic/guidelines.cfm - 7479>): The draft handbook is designed to supplement the *Voluntary National Guidelines* by providing tools for program implementation. It is a compilation of case studies, detailed discussions, and supplementary material to provide assistance in implementing management programs.

Selection of Treatment Technology

- **National Small Flows Clearinghouse, Environmental Technology Initiative (ETI) Fact Sheets** (http://www.nesc.wvu.edu/nsfc/nsfc_etifactsheets.htm): The ETI fact sheets describe innovative and alternative onsite wastewater treatment technologies for single families, clusters of homes, subdivisions, and communities. For each technology, general and technical fact sheets are available. The fact sheets were created as part of USEPA's Environmental Technology Initiative.

Homeowner Education

- **Stinson Beach County Water District, Onsite Wastewater Management Program, Homeowner's Guide** (<http://stinson-beach-cwd.dst.ca.us/wastehome.html>): This manual provides information for homeowners on septic system function and maintenance, signs of failure, and basic dos and don'ts.
- **USEPA, Homeowner Education Materials** (<http://cfpub.epa.gov/owm/septic/home.cfm>): These educational materials are available free of charge, either as hard copies or in electronic form. They can be customized to reflect local contact information.

System Inspection, Operation, and Maintenance

- **D. Friedman, The Septic Information Web site** (<http://www.inspect-ny.com/septbook.htm>): This Web site features a compilation of technical resources; links to industry, government, universities and consultants; and information for homeowners.
- **WATERSHEDSS: Water, Soil and Hydro-Environmental Decision Support System, Septic Systems** (<http://www.water.ncsu.edu/watershedss/dss/wetland/aqlife/septic.html - mm>): This fact sheet describes management practices for onsite wastewater treatment systems, including alternative treatment technologies such as denitrification systems and regulatory practices such as restrictions on garbage disposals and chemical additives.
- **USEPA, Failing Septic Systems Fact Sheet** (http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/illi_1.cfm): This fact sheet describes measures to address failing septic systems, and includes cost and effectiveness information.
- **J. Riordan, Septic System Checkup: A Rhode Island Handbook for Inspection** (<http://www.state.ri.us/dem/pubs/regs/regs/water/isdsbook.pdf>): This is Rhode Island's online inspection guide, published in 2000.

Septage/Residual Disposal

- **USEPA, Decentralized Systems Technology Fact Sheet: Septage Treatment/Disposal** (<http://www.epa.gov/owm/mtb/septage.pdf>): This fact sheet provides background information on septage from various sources and details on various options for treatment and disposal of septage.
- **USEPA, Process Design Manual: Land Application of Sewage Sludge and Domestic Septage** (<http://www.epa.gov/ORD/WebPubs/landapp.pdf>): This manual provides detailed guidance on the development of a land application program.

2.3.10.4 Case Studies

Septic System Management Task Force. The Santa Monica Bay Restoration Commission created a Task Force on Septic System Management that involved multiple state and local regulatory agencies, environmental organizations, and health departments. The goals of the Task Force were to address human health and water quality problems related to septic systems and options for improving septic system management in the northern Santa Monica Bay watersheds. Recommendations were based on programs implemented in other states, water quality data, and the current regulatory framework for septic system management. The Commission continues to cooperate with regulatory agencies to assist in the

implementation of these recommendations (<http://www.santamonicabay.org/site/programs/layout/task.jsp-54>).

San Lorenzo River Basin, Wastewater Management Program. This project was developed to assist in the development of a management program for existing onsite wastewater treatment systems, including inspection, maintenance, and upgrades. Since 1985, the Santa Cruz County Environmental Health Service has been working to develop a program for inspecting all onsite systems, assessing pollutant loads, and making necessary repairs. Studies conducted through this initiative included calculations of nutrient inputs to the river from onsite systems (http://sccounty01.co.santa-cruz.ca.us/eh/environmental_water_quality/pdfs/slv_wastewater_management_plan_status_report_1996-1998.pdf).

2.3.10.5 References

USEPA. 2002. *Onsite Wastewater Treatment Systems Manual*. EPA/625/R-00/008. U.S. Environmental Protection Agency, Office of Water, Washington, DC.
([http://www.epa.gov/ORD/NRMRL/Pubs/625R00008/625R00008.htm - links](http://www.epa.gov/ORD/NRMRL/Pubs/625R00008/625R00008.htm-links))

2.3.11 Management Measure 3.5A Transportation Development Planning, Siting, and Developing Roads and Highways

Fact Sheet Links:

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- [Case Study](#)
- [References](#)

Management Measure

Plan, site, and develop roads and highways to:

1. Protect areas that provide important water quality benefits or are particularly susceptible to erosion or sediment loss;
2. Limit land disturbance such as clearing and grading and cut and fill to reduce erosion and sediment loss; and
3. Limit disturbance of natural drainage features and vegetation.

2.3.11.1 Programs

California Department of Transportation (Caltrans), Storm Water Management Program. Caltrans is the agency responsible for managing California's highway system. With its statewide Storm Water Management Program, Caltrans is helping to prevent the adverse effects of storm water runoff from Caltrans roadways and facilities. This program provides a comprehensive effort to preserve and improve water quality in California (<http://www.dot.ca.gov/hq/env/stormwater/index.htm>).

Surface Transportation Policy Project (STPP). STPP's California field offices provide assistance to local transportation agencies, elected officials, and citizen groups to help stakeholders take advantage of the new opportunities available under the federal transportation bill to link transportation to land use, housing, social equity, livable communities, and smart growth (<http://www.transact.org/ca/environment.htm>).

2.3.11.2 Management Practices

The type and location of permanent storm water management practices should be considered when planning highways, roads, and bridges, such that rights-of-way are sized to accommodate structural controls.

Highways and roads should be planned to minimize mileage through areas that might adversely affect sensitive areas, such as wetlands or estuaries. Wetlands that are within the right-of-way and cannot be avoided should be protected with the use of mitigation measures. Highway and road construction should be limited in sensitive areas, and highways should be sited so there is a sufficient setback distance between the highway right-of-way and any wetland or riparian areas. Another consideration is tidal flows to wetlands; highways and rights-of-way should not restrict this flow. Mitigation will likely be required if wetlands, riparian areas, or estuaries are affected.

Curbs can be eliminated (when local development codes permit) to allow highway and road runoff to be filtered through vegetated shoulders and medians. Eliminating curbs also increases infiltration to ground water. If eliminating curbs is not possible, curbs can be designed with breaks to direct runoff to vegetated surfaces. Care must be taken to ensure that the curb breaks do not receive so much runoff as to erode the vegetated infiltration area.

Storm water control structures should be designed so that the storm water does not run directly to receiving waters. This practice is often referred to as disconnecting impervious surfaces. Highway runoff should be routed through a combination of treatment practices or over stabilized vegetated areas before it enters receiving waters.

2.3.11.3 Information Resources

- **Caltrans Environmental Handbook, Volume 3** (<http://www.dot.ca.gov/ser/envhand.htm>): This volume provides guidance on the identification and evaluation of biological resources, processing of biological resource documents, and implementation of biologically related construction, maintenance, and encroachment activities. Volume 3 of the *Environmental Handbook* should be used in conjunction with other project planning and development manuals as well as with Volume 1.
- **Caltrans Environmental Handbook, Volume 5** (<http://www.dot.ca.gov/ser/envhand.htm>): This volume, which is still in preparation, will provide guidance on storm water management.
- **Caltrans, Statewide Storm Water Management Plan** (http://www.dot.ca.gov/hq/env/stormwater/special/newsetup/pdfs/management_ar_rwp/CTSW-RT-02-008.pdf). The plan, approved by the SWRCB in March 2003, describes procedures and practices Caltrans uses to manage pollutants discharged from storm water drainage systems.
- **Caltrans Internet Water Quality Planning Tool** (<http://www.dot.ca.gov/hq/env/stormwater/index.htm>): Available only on the Internet, the Water Quality Planning Tool is a database of water quality standards and possible pollutants from Caltrans facilities. This unique tool is another valuable resource being used by Caltrans in its continuing commitment to prevent storm water pollution.
- **California Wetland Information System** (<http://ceres.ca.gov/wetlands/>): The California Wetland Information System is designed to provide wetland information to the public, educational community, and government agencies. It includes information on wetland mitigation and the mitigation role and responsibility for the California Department of Transportation (<http://ceres.ca.gov/wetlands/agencies/caltrans.html>).
- **Washington Department of Transportation, Roadside Manual** (<http://www.wsdot.wa.gov/eesc/design/roadside/default.htm#rm>): The purpose of this manual is to provide guidance on roadside maintenance, including planning, design, construction, and maintenance. The manual has information on sustainable roadsides, environmental functions, wetlands, water quality, parking area design, erosion control, contour grading, soil bioengineering, and vegetative restoration concepts.

2.3.11.4 Case Study

Folsom, California, Dual Drainage System. In Folsom, an arterial street was outfitted with a dual drainage system, which has separate systems to treat runoff for water quality during smaller storms and runoff quantity and timing during larger storms (Richman et al., 1998). The system consists of grassy swales that use a conventional curb-and-gutter system. Two catch basins are included in the design. The

first basin collects the first flush of rainfall from a 2-year storm and discharges the effluent into a grassy swale for treatment. The treated runoff is then directed into the main storm drainage system. The second catch basin, located downstream, collects flows beyond the 2-year storm (up to a 10-year storm) that are not handled by the first system, and discharges this flow directly to the storm drainage system.

2.3.11.5 References

- Metropolitan Washington Council of Governments. 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs*. Metropolitan Washington Council of Governments, Washington, DC. (http://www.mwcog.org/store/item.asp?PUBLICATION_ID=104)
- Richman, T., K.H. Lichten, J. Worth, and B.K. Ferguson. 1998. *Landscape Architecture Technical Information Series: Vegetated Swales*. American Society of Landscape Architects, Washington, DC. (<http://www.asla.org/latis/Latis2.pdf>)
- USEPA. 2005. *National Management Measures to Control Nonpoint Source Pollution from Urban Areas*. EPA 841-B-05-004. U.S. Environmental Protection Agency, Washington, DC. (<http://www.epa.gov/owow/nps/urbanmm>)

2.3.12 Management Measure 3.5B Transportation Development Bridges

Fact Sheet Links:

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- [Case Studies](#)
- [References](#)

Management Measure

Site, design, and maintain bridge structures so that sensitive and valuable aquatic ecosystems and areas providing important benefits are protected from adverse effects.

Bridges by their nature are built in riparian areas and can have pronounced habitat and water quality impacts if care is not taken to protect sensitive areas from both construction and post-construction impacts. Practices to meet these goals include designing bridges to minimize damage to riparian or wetland habitats and treating runoff from bridge decks before it is allowed to enter watercourses. Bridge maintenance activities should be conducted using containment practices to prevent pollutants, such as paint, rust, hazardous chemicals, and building materials, from entering the water or riparian habitat below. Restoration of damaged riparian or instream habitats should be done after bridge construction, maintenance, and demolition.

2.3.12.1 Programs

California Department of Transportation (Caltrans) Storm Water Management Program. Caltrans is the agency responsible for managing California's highway system. With its statewide Storm Water Management Program, Caltrans is helping to prevent the adverse effects of storm water runoff from Caltrans roadways and facilities. This program provides a comprehensive effort to preserve and improve water quality in California (<http://www.dot.ca.gov/hq/env/stormwater/index.htm>).

Surface Transportation Policy Project (STPP). STPP's California field offices provide assistance to local transportation agencies, elected officials, and citizen groups to help stakeholders take advantage of the new opportunities available under the federal transportation bill to link transportation to land use, housing, social equity, livable communities, and smart growth (<http://www.transact.org/ca/environment.htm>).

Through the Clean Water Act section 401 certification program, RWQCBs review projects that require a federal permit under CWA section 404 or involve dredge or fill activities that may result in a discharge to waters of the United States. This is to ensure that the State's interests are protected on any federally permitted activity occurring in or adjacent to waters of the State. Detailed information about CWA section 401 in California, including a description of the program, resources, legal background information, proposed projects, and links, are described on the SWRCB Web site (<http://www.swrcb.ca.gov/cwa401/index.html>).

2.3.12.2 Management Practices

Bridges should be planned to minimize mileage and protect sensitive areas such as wetlands or estuaries. Setbacks should be used for river crossings during construction to minimize disturbance to the riparian area. Bridge construction can adversely impact water circulation in wetland areas, so allowances should be made for these impacts when designing bridges. Areas requiring excessive cut and fill and those that may be subject to subsidence, sink holes, landslides, rock outcropping, and highly erodible soils should be avoided when siting bridge locations.

Runoff should be directed away from bridge decks and watercourses by diverting it toward land for treatment. This can be accomplished using drains that pipe water along the bridge edge to either side of the shore. Recommended practices for treating bridge deck runoff include ponds, wetlands, infiltration basins and trenches, media filters, bioretention areas, vegetated swales, filter strips, and hydrodynamic devices. The use of scupper drains should be restricted on bridges less than 400 feet long and on bridges crossing sensitive areas.

2.3.12.3 Information Resources

- **Caltrans Environmental Handbook, Volume 3** (<http://www.dot.ca.gov/ser/envhand.htm>): This volume provides guidance on the identification and evaluation of biological resources, processing of biological resource documents, and implementation of biologically related construction, maintenance, and encroachment activities. Volume 3 of the *Environmental Handbook* should be used in conjunction with other project planning and development manuals and with Volume 1.
- **Caltrans Environmental Handbook, Volume 5** (<http://www.dot.ca.gov/ser/envhand.htm>): This volume, which is currently in preparation, will provide guidance on storm water management.
- **Caltrans, Statewide Storm Water Management Plan** (http://www.dot.ca.gov/hq/env/stormwater/special/newsetup/pdfs/management_ar_rwp/CTSW-RT-02-008.pdf). The plan, approved by the SWRCB in March 2003, describes procedures and practices Caltrans uses to manage pollutants discharged from storm water drainage systems.
- **Caltrans Internet Water Quality Planning Tool** (<http://www.dot.ca.gov/hq/env/stormwater/index.htm>): Available only on the Internet, the Water Quality Planning Tool is a database of water quality standards and possible pollutants from Caltrans facilities. This unique tool is another valuable resource being used by Caltrans in its continuing commitment to prevent storm water pollution.
- **Washington Department of Transportation Roadside Manual** (<http://www.wsdot.wa.gov/eesc/design/roadside/default.htm - rm>): The purpose of this manual is to provide guidance on roadside maintenance, including planning, design, construction, and maintenance. The manual has information on sustainable roadsides, environmental functions, wetlands, water quality, parking area design, erosion control, contour grading, soil bioengineering, and vegetative restoration concepts.

2.3.12.4 Case Studies

North Coast River Loading Study. This study will look at how storm water runoff from bridges affects water quality, fish, and aquatic life. Sediment, nutrients, and temperature changes will be studied to determine how these pollutants may adversely affect coho salmon and steelhead trout. Information about water quality gathered from this watershed will be valuable for future TMDL (total maximum daily load) studies along the North Coast. It will also provide a basis for future cooperative efforts between Caltrans

and watershed landowners working together to reduce stream pollutants (<http://www.dot.ca.gov/hq/env/stormwater/index.htm>).

Road Crossings on Small Streams. Bridge crossings over streams can affect aquatic habitat in several ways. Sediment from eroded banks during and after construction and storm water runoff from bridges can affect water quality and organisms in the streams (<http://www.dot.ca.gov/hq/env/stormwater/index.htm>).

This study, which is being conducted in the Navarro watershed, will

- Identify the sources of pollution to the major streams in the watershed
- Identify different types of aquatic life within the stream community
- Determine the availability of habitat for salmon and steelhead
- Compare the condition of the riparian area to the health of stream communities
- Investigate the movement of sediment within the stream
- Analyze storm water runoff using standard toxicology tests to determine the effects on living organisms

2.3.12.5 References

- Metropolitan Washington Council of Governments. 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs*. Metropolitan Washington Council of Governments, Washington, DC. (http://www.mwcog.org/store/item.asp?PUBLICATION_ID=104)
- USEPA. 2005. *National Management Measures to Control Nonpoint Source Pollution from Urban Areas*. EPA 841-B-05-004. U.S. Environmental Protection Agency, Washington, DC. (<http://www.epa.gov/owow/nps/urbanmm>)

2.3.13 Management Measure 3.5C Transportation Development Construction Projects

Management Measure

1. Reduce erosion and, to the extent practicable, retain sediment on site during and after construction; and
2. Prior to land disturbance, prepare and implement an approved erosion control plan or similar administrative document that contains erosion and sediment control provisions.

See [Management Measure 3.2A](#) for programs, practices, and information resources relating to erosion and sediment control at construction sites. The same practices apply to transportation projects.

2.3.14 Management Measure 3.5D Transportation Development Chemical Control

Management Measure

1. Limit application, generation, and migration of toxic substances;
2. Ensure the proper storage and disposal of toxic materials;
3. Apply nutrients at rates necessary to establish and maintain vegetation without causing significant nutrient runoff to surface waters.

See [Management Measure 3.2B](#) for programs, practices, and information resources relating to chemical control at construction sites. The same practices apply to transportation projects.

2.3.15 Management Measure 3.5E Transportation Development Operation and Maintenance

Fact Sheet Links:

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- [Case Studies](#)
- [References](#)

Management Measure

Incorporate pollution prevention procedures into the operation and maintenance of roads, highways, and bridges to reduce pollutant loadings to surface waters.

Road and bridge maintenance activities can generate pollutants when runoff carries road surfacing materials, sealants, road salt, sand, and deicing chemicals into receiving waters. In addition, soil can erode when rights-of-way are cleared or disturbed. Practices to prevent such pollution include erosion and sediment controls for exposed soils, covering, and surrounding with berms or other secondary containment materials that are stockpiled for maintenance activities. For winter deicing activities, materials to be used should be carefully selected to avoid causing or exacerbating specific water quality problems. For example, where salinity might be a problem in receiving waters, road salt should be avoided and sand used instead.

Motor vehicles generate runoff pollutants through the emission and deposition of automobile exhaust and through discharges of both fluids and solid particles during travel and while braking (USEPA, 2005). These pollutants include hydrocarbons and heavy metals. In a study of traffic-generated particulates in Cincinnati (where the average daily traffic is 150,000 vehicles), Sansalone and Buchberger (1997) found that 15 percent of the 13,500 milligrams (mg) of particulates per square meter of road surface generated per day originated from engine and brake pad wear. The study also found that 6 percent of particulates were deposited from settleable exhaust. The other proportions originated from pavement wear (44 percent to 49 percent), tire wear (28 percent to 31 percent), and atmospheric deposition (3 percent).

2.3.15.1 Programs

California Department of Transportation, Division of Maintenance, Roadside Maintenance Program. This program is responsible for vegetative control and the Adopt-a-Highway Program. (<http://www.dot.ca.gov/hq/maint/roadside.htm>).

California Department of Transportation, Division of Maintenance, Roadway Maintenance Program. This program manages rehabilitation and maintenance of pavement and snow and ice control (<http://www.dot.ca.gov/hq/maint/roadway.htm>).

California Department of Transportation (Caltrans) Adopt-A-Highway Program. The Caltrans Adopt-A-Highway Program provides an avenue for individuals, organizations, or businesses to help maintain sections of roadside within California's State Highway System (<http://adopt-a-highway.dot.ca.gov/>).

California Department of Pesticide Regulation's (DPR) Surface Water Protection Program. This program protects human health and the environment by preventing pesticides from adversely affecting surface waters, by addressing both agricultural and nonagricultural sources of pesticide residues in surface waters. It has preventive and response components that reduce the presence of pesticides in surface waters (<http://www.cdpr.ca.gov/docs/sw/>).

2.3.15.2 Management Practices

Road Repairs

Potholes and cracks in road surfaces and retaining walls should be repaired promptly to prevent further degradation of the road surface. When these activities, along with road expansion and repaving, disturb vegetated areas, the exposed soils should be protected from erosion using erosion and sediment controls (see [Management Measure 3.2A](#)) and denuded areas should be revegetated using seed, mulch, or sod immediately after road work has been completed.

When performing bridge maintenance activities, use enclosures, and containment and collection systems to collect pollutants. Recommended enclosures include free hanging enclosures, total structure enclosures, and negative pressure systems, and recommended containment and collection systems include: cofferdams, barges, containment booms, and vacuum sanders. A runoff control plan should be in place for each large project, and smaller projects should be governed by standard operating procedures to prevent contamination of storm flows and to control spills.

Winter Maintenance

Chemicals and abrasives used to prevent ice on road surfaces in winter should be stored on an impervious pad and covered to prevent runoff from carrying away any of the materials. Not only does this prevent runoff pollution, but it also preserves the materials for their intended use. Stockpiled deicing materials should not be stored in floodplains.

Deicing materials should be selected and applied to cause minimal harm to the environment. Where areas might be sensitive to salinization, alternatives to road salt, such as sand or any number of organic products that are currently on the market, can be used. Organic products should be avoided in areas that have low biochemical oxygen demand. Sand should not be used in areas with sediment problems such as excessive streambank scour or embedded gravels.

When applying materials, care should be taken to apply only the amount of material that is required to provide a safe road surface. Local studies can be undertaken to determine the appropriate amount of deicing materials to be used for different road surfaces in different conditions and locations.

Snow that is plowed from road surfaces should never be stockpiled on or near frozen surface waters or retention ponds. Once the snow and ice has melted, road surfaces should be swept or vacuumed to remove and reclaim sand, salt, or other deicing chemicals. This material can be recycled or disposed of in a locally approved manner.

Trash and Debris Removal

Streets and parking lots should be periodically swept or vacuumed to remove trash and debris. The frequency with which each area or road is swept should depend on the quantity of trash that is seen over time. Areas that are heavily traveled or tend to attract litter should be swept more frequently. Also, areas that drain to sensitive receiving waters or areas that have known trash and debris problems should be swept more frequently.

Anti-litter signage should be posted throughout the community, especially in places with known trash/debris problems. Litter and dumping laws should be strictly enforced, and the municipality should provide a hotline or other medium for citizens to report littering or dumping.

2.3.15.3 Information Resources

- **Federal Highway Administration, *Manual of Practices for an Effective Anti-Icing Program: A Guide for Highway Winter Maintenance Personnel*** (<http://www.fhwa.dot.gov/reports/mopeap/mop0296a.htm>): The manual was written to guide maintenance managers in developing a systematic and efficient practice for maintaining roads in the best conditions possible during a winter storm. It describes the significant factors that should be understood and must be addressed in an anti-icing program, with the recognition that the development of the program must be based on the specific needs of the site or region within its reach. It focuses on the weather information, materials, and methods that will best address site conditions such as level of service, highway agency resources, climatological conditions, and traffic.
- **Transportation Research Board publications** (<http://www4.trb.org/trb/onlinepubs.nsf>): The Transportation Research Board has prepared several studies that investigate the environmental impacts of activities related to transportation infrastructure, including such titles as *Assessing the Impacts of Bridge Deck Runoff Contaminants in Receiving Waters*, *Mitigating Highway Runoff Constituents Via a Wetland*, *Characteristics of Storm-Water Runoff from Highway Construction Sites in California*, and others.
- **Pacific Northwest Snowfighters Association** (<http://www.wsdot.wa.gov/partners/pns/>): This site provides resources on deicing and anti-icing products and practices.
- **California Department of Transportation (Caltrans), Storm Water Management Program** (<http://www.dot.ca.gov/hq/env/stormwater/index.htm>). Caltrans is the agency responsible for managing California's highway system. With its statewide Storm Water Management Program, Caltrans is helping to prevent the adverse effects of storm water runoff from Caltrans roadways and facilities. This program provides a comprehensive effort to preserve and improve water quality in California.
- **Washington Department of Transportation, *Roadside Manual*** (<http://www.wsdot.wa.gov/eesc/design/roadside/default.htm#rm>). The purpose of this manual is to provide guidance on roadside maintenance, including planning, design, construction, and maintenance. The manual has information on sustainable roadsides, environmental functions, wetlands, water quality, parking area design, erosion control, contour grading, soil bioengineering, and vegetative restoration concepts.
- **Center for Watershed Protection *Snow, Road Salt and the Chesapeake Bay*** (http://www.cwp.org/rr_photos/jan05/snowandsalt.pdf): The Center for Watershed Protection published a paper that examines what happens to the salts and other chemicals applied to the roads in the winter and what is known about their impact on the environment. The paper addresses the environmental impacts of salt and includes ways to reduce the use of salt.

2.3.15.4 References

California Department of Transportation. 1998. *Maintenance Manual: Volume 1*. California Department of Transportation, Sacramento, CA. (<http://www.dot.ca.gov/hq/maint/manual/maintman.htm>)

- Metropolitan Washington Council of Governments. 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs*. Metropolitan Washington Council of Governments, Washington, DC. (http://www.mwcog.org/store/item.asp?PUBLICATION_ID=104)
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- San Francisco RWQCB. 1998. *Erosion and Sediment Control Field Manual*. San Francisco Regional Water Quality Control Board, San Francisco, CA.
- Sansalone, J.J., and S.G. Buchberger. 1997. Partitioning and First Flush of Metals in Urban Roadway Storm Water. *Journal of Environmental Engineering* 123(2): 134–143.
- USEPA. 2005. *National Management Measures to Control Nonpoint Source Pollution from Urban Areas*. EPA 841-B-05-004. U.S. Environmental Protection Agency, Washington, DC. (<http://www.epa.gov/owow/nps/urbanmm>)

2.3.16 Management Measure 3.5F Transportation Development Road, Highway, and Bridge Runoff Systems

Fact Sheet Links:

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- [Case Studies](#)
- [References](#)

Management Measure

Develop and implement runoff management systems for existing roads, highways, and bridges to reduce runoff pollutant concentrations and volumes entering surface waters.

1. Identify priority watershed pollutant reduction opportunities (e.g., improvements to existing urban runoff control structures); and
2. Establish schedules for implementing appropriate controls.

This management measure acknowledges the fact that roads built in the past may not have the same level of runoff control and treatment that is expected today. These older roads may be contributing to pollution problems in receiving waters. Municipalities responsible for road and bridge rights-of-way should undertake an assessment of the roads' and bridges' contribution to surface waters and identify opportunities for installing new treatment practices. Based on water quality priorities and the availability of staff and funding resources, a schedule should be devised to implement these practices.

2.3.16.1 Programs

Caltrans Storm Water Management Program. Caltrans is the agency responsible for managing California's highway system. With its statewide Storm Water Management Program, Caltrans is helping to prevent the adverse effects of storm water runoff from Caltrans roadways and facilities. This program provides a comprehensive effort to preserve and improve water quality in California (<http://www.dot.ca.gov/hq/env/stormwater/index.htm>).

Surface Transportation Policy Project (STPP). STPP's California field offices provide assistance to local transportation agencies, elected officials, and citizen groups to help stakeholders take advantage of the new opportunities available under the federal transportation bill to link transportation to land use, housing, social equity, livable communities, and smart growth (<http://www.transact.org/ca/environment.htm>).

2.3.16.2 Management Practices

Runoff treatment facilities can be located within existing rights-of-way, medians, or interchange loops, or on adjacent lands (e.g., golf courses and parks). Where no additional land is available, underground runoff storage and treatment (e.g., sand filters) can be used. Vegetative filter strips along roadsides and in medians can be effective at slowing runoff velocities and increasing storm water infiltration. Curbs should be eliminated to allow highway and road runoff to be filtered through vegetated shoulders and medians. Eliminating curbs also increases infiltration to ground water. If eliminating curbs is not possible, curbs can be designed with breaks and energy dissipaters to direct sheet flow to vegetated surfaces. These infiltration areas will require periodic inspection for damage, rilling, ponding, and trash accumulation, and will also require mowing or cropping of vegetation to prevent nuisance conditions.

Soil bioengineering techniques can be used in lieu of retaining walls for slope stabilization practices where sloped roadsides are deteriorating. Practices such as live stakes, fascines, brush layers, branchpacking, live gully repair, live cribwalls, vegetated rock gabions, vegetated rock walls, and joint planting are recommended for relatively moderate slopes where vegetation can be established.

2.3.16.3 Information Resources

- **Caltrans *Environmental Handbook*, Volume 5** (<http://www.dot.ca.gov/ser/envhand.htm>): This volume, which is still in preparation, will provide guidance on storm water management.
- **Caltrans, Statewide Storm Water Management Plan** (http://www.dot.ca.gov/hq/env/stormwater/special/newsetup/pdfs/management_ar_rwp/CTSW-RT-02-008.pdf). The plan, approved by the SWRCB in March 2003, describes procedures and practices Caltrans uses to manage pollutants discharged from storm water drainage systems.
- **Caltrans Internet Water Quality Planning Tool** (<http://www.dot.ca.gov/hq/env/stormwater/index.htm>): Available only on the Internet, the Water Quality Planning Tool is a database of water quality standards and possible pollutants from Caltrans facilities. This unique tool is another valuable resource being used by Caltrans in its continuing commitment to prevent storm water pollution.
- **Washington State Department of Transportation (WSDOT), Soil Bioengineering** (<http://www.wsdot.wa.gov/eesc/design/roadside/sb.htm>): WSDOT has a Web page that provides information on soil bioengineering, from designing projects to costs, funding, contractors, and native plant supplies. The site also showcases past projects and provides links to several online information sources.
- **WSDOT, Roadside and Site Development Unit** (<http://www.wsdot.wa.gov/eesc/design/roadside/default.htm>): The Roadside and Site Development Unit has a roadside technology transfer center that shares information with the public on technologies such as soil bioengineering, revegetation, soils, and permanent erosion control. The *Roadside Manual* (<http://www.wsdot.wa.gov/eesc/design/roadside/default.htm-rm>) provides guidance on roadside maintenance, including planning, design, construction, and maintenance. The manual has information on sustainable roadsides, environmental functions, wetlands, water quality, parking area design, erosion control, contour grading, soil bioengineering, and vegetative restoration concepts.

2.3.16.4 References

- Metropolitan Washington Council of Governments. 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs*. Metropolitan Washington Council of Governments, Washington, DC. (http://www.mwcog.org/store/item.asp?PUBLICATION_ID=104)
- San Francisco RWQCB. 1998. *Erosion and Sediment Control Field Manual*. San Francisco Regional Water Quality Control Board, San Francisco, CA.
- USEPA. 2005. *National Management Measures to Control Nonpoint Source Pollution from Urban Areas*. EPA 841-B-05-004. U.S. Environmental Protection Agency, Washington, DC. (<http://www.epa.gov/owow/nps/urbanmm>)

2.3.17 Management Measure 3.6A Education/Outreach Pollution Prevention/Education

Fact Sheet Links:

- [Programs](#)
- [Management Practices](#)
- [Information Resources](#)
- [Case Study](#)
- [References](#)

Management Measure

Implement educational programs to provide greater understanding of watersheds and to raise awareness and increase the use of applicable urban management measures and practices where needed to control and prevent adverse impacts on surface and ground waters. Public education, outreach, and training programs should involve applicable user groups and the community. Implementation of urban pollution prevention and education programs includes the following subjects, where applicable:

1. Households: Improper storage, use, and disposal of household hazardous chemicals, including automobile fluids, pesticides, paints, and solvents; lawn and garden activities, including the application and disposal of lawn and garden care products, and improper disposal of leaves and yard trimmings; improper operation and maintenance of onsite disposal systems; and improper disposal of pet excrement.
2. Landscaping: Turf management on golf courses and in parks and recreational areas.
3. Commercial: Commercial activities, including parking lots, restaurants, vehicle service facilities, and other entities.
4. Other General Sources: Discharge of pollutants (including floatables, waste oil, and litter) into storm drains; roads, highways, and bridges.

2.3.17.1 Programs

California Integrated Waste Management Board (CIWMB). The CIWMB provides assistance with solid waste minimization and pollution prevention. Material-specific guidance, educational materials, and information on financial assistance are provided for industry and the general public (<http://www.ciwmb.ca.gov/>).

California Department of Toxic Substance Control (DTSC) Pollution Prevention (P2) Program. The P2 Program provides resources for industry, local government, and other environmental agencies to promote source reduction and pollution prevention. This includes technology transfer, inspection/enforcement program support, and public outreach (<http://www.dtsc.ca.gov/PollutionPrevention/>).

California Department of Pesticide Regulation, Home2Ocean Program. The Home2Ocean Web site provides information for residential users of pesticides on their proper use and disposal. The Home2Ocean workbook is a capacity-building resource for launching or conducting a public education program for preventing water pollution from household pesticides (<http://www.cdpr.ca.gov/docs/h2o/index.htm>).

City of San Diego's Storm Water Pollution Prevention Program. The program aims to reduce pollution in urban runoff through a variety of programs. These include public education, training programs, monitoring for water quality, watershed management, and the development and implementation of management practices (<http://www.sannet.gov/stormwater/index.shtml>).

Alameda Countywide Clean Water Program (ACCWP). The ACCWP is a consortium of local agencies in Alameda County dedicated to preventing urban storm water pollution. The program grew out of a need to meet NPDES requirements and participate in the development of the Water Quality Control Plan for the San Francisco Bay region. The program engages in efforts to educate the general public, contractors, and government employees through the distribution of literature, information fairs, training workshops, and television ads. In addition, the consortium works to identify and correct illicit discharges into the storm water system (<http://www.ci.berkeley.ca.us/PW/Storm/stormala.html>).

San Mateo Countywide Stormwater Pollution Prevention Program (STOPPP). STOPPP serves as a community resource for pollution prevention, focusing on educating residential and business communities via publications on management practices, commercials, and training programs (<http://www.flowstobay.org/index.html>).

California Environmental Protection Agency, Permit Assistance Centers. In addition to helping businesses to comply with permit requirements, this program provides referrals for pollution prevention assistance and other business assistance programs. The Web site lists pollution prevention resources relevant to California businesses (<http://www.calgold.ca.gov/P2/>).

Plastic Debris River to Sea. The Plastic Debris River to Sea project, a project of the Algalita Marine Research Foundation in collaboration with the SWRCB and CCC, is testing the effectiveness current industry-generated management practices, known as Operation Clean Sweep, to control discharges of plastic debris through urban runoff from the plastics manufacturing sector. It is also measuring the emissions of small plastic fragments in the Los Angeles and San Gabriel rivers to determine whether existing regulations, such as the trash TMDLs, are effective at controlling discharges of pellets and other plastic fragments from urban waterways to the ocean. The project is assessing the materials and products that make up the litter and other discarded materials that flow through the Los Angeles and San Gabriel rivers to the ocean. Based on this assessment, the Project is developing an Action Plan for the state of California that will identify different behaviors and problems that contribute plastics and other discarded materials to urban runoff. It will suggest actions to stop the flow of plastics and other discarded materials in urban runoff. The Plan will be shared with local and state government agencies, legislators, industry and parties interested in storm water pollution and ocean protection (<http://www.plasticdebris.org/>).

2.3.17.2 Management Practices

Pollution prevention practices are those that seek to educate the public on the potential for everyday activities to create NPS pollution. Pollution is generated by everyday household activities, commercial and residential lawn and garden care, commercial activities, pet waste, and trash.

Everyday household chemicals can be considered pollutants if they are improperly handled, stored, or disposed of. Automotive substances, household cleaners, fertilizers, pesticides, and home improvement materials must all be carefully managed to prevent contamination of runoff or ground water. Car washing can flush nutrients, metals and hydrocarbons into storm drains. Watershed managers can address these problems through public outreach and education efforts such as pamphlet distribution, training on proper lawn care practices, and storm drain stenciling. Municipalities should also provide facilities for the disposal of household chemicals.

In residential neighborhoods, pet waste can also be a major contributor to NPS pollution. Pet owners can be informed about proper disposal of waste, and municipalities can install “pet waste stations,” pass and enforce “pooper scooper” ordinances, and post signs.

Outreach campaigns should also inform both commercial lawn care specialists and residents of the importance of proper application of fertilizers and pesticides. In particular, techniques such as Integrated Pest Management and timing of fertilizer application should be emphasized to provide citizens with the tools to use these substances efficiently and reduce overall pesticide and fertilizer use.

One way commercial activities can generate NPS pollution is through the release of wastewater into a storm sewer system without a permit (this is known as an illicit discharge). Municipalities must develop programs to help detect and eliminate these illicit discharges, as well as educate businesses and their employees. Commercial and industrial establishments should also implement good housekeeping practices, employee education and training programs and spill prevention plans. Measures should be taken to reduce the possibility of spills or leaks during general operation, maintenance, washing, construction, or repairs and to limit the exposure of pollutants to areas where they might come in contact with storm water.

Municipalities should implement good housekeeping practices, including programs to control trash, debris collected from street sweeping, stockpiled material, and corporation yard pollutant sources, and reduce pollutants from activities such as park and road maintenance. Programs that reduce the amount of trash on the streets include public education, increased waste disposal facilities and cleanup campaigns. Municipalities can also clean streets and prevent trash from entering storm water with street sweeping and trash collection devices for storm drain inlets.

Finally, municipalities should inform the public of local stewardship groups and encourage participation among them. Local governments can organize environmental stewardship groups that focus specifically on urban pollution prevention if they do not already exist. Increasing public participation in stewardship groups will help to better facilitate outreach and education and will result in greater buy-in by the community nonpoint source and storm water control efforts. In addition, educational programs that encourage environmental stewardship among younger populations can help to ensure long-term nonpoint source and watershed awareness and can help bring the stewardship message home to family members.

2.3.17.3 Information Resources

General Pollution Prevention Web sites

- **Stormwater Manager's Resource Center, Fact Sheets on Pollution Prevention Practices** ([http://www.stormwatercenter.net/Assorted Fact Sheets/Tool8-Stewardship/municipal.htm](http://www.stormwatercenter.net/Assorted%20Fact%20Sheets/Tool8-Stewardship/municipal.htm)): These fact sheets describe various residential storm water pollution prevention practices.
- **USEPA, Pollution Prevention Information Clearinghouse (PPIC)** (<http://www.epa.gov/opptintr/library/ppicindex.htm>): The PPIC houses USEPA documents, pamphlets, and fact sheets on pollution prevention. It also answers questions about pollution prevention and provides referrals for technical assistance and additional information.
- **California Consortium of Pollution Prevention Committees** (http://www.westp2net.org/c2p2c/c2p2c_main.htm): The consortium's Web site provides links to various pollution prevention organizations in California. The consortium is part of the Western Region Pollution Prevention Network.
- **California Coastal Commission, Model Urban Runoff Program (MURP)** (<http://www.coastal.ca.gov/la/murp.html>): MURP is a step-by-step guide designed for small municipalities to help them manage NPS pollution from urban runoff in California.

Educational Resources

- **Orange County Stormwater Program**
(http://www.ocwatersheds.com/PublicEducation/pe_brochures.asp): The public education program Web site includes a number of brochures on pollution prevention for residents and businesses. The brochures can be downloaded and printed copies can be ordered.
- **University of Wisconsin Cooperative State Research, Education, and Extension Service, Best Education Practices Project** (<http://wateroutreach.uwex.edu/>): The University of Wisconsin Cooperative State Research, Education, and Extension Service has initiated the Water Outreach Education project, also known as the Best Education Practices project, to help natural resource management and outreach professionals to choose appropriate education techniques and resources for their water management programs. The Best Education Practices project will work in collaboration with the federal agency clean and safe water partnership and other networks to develop and promote best education practices for water education and to improve access to education resources and strategies. Project activities reflect advice provided by federal agency clean and safe water partners and a national network of water education organizations created and supported by the work of several national organizations over the last decade. Projects have included a 2002 Study of Provider Needs, Model Education Technique, a literature search, Best Education Practices Pilot Web site, and other reference materials related to water outreach education.
- **USEPA Watershed Academy Web site** (<http://www.epa.gov/watertrain/>): This Web site offers 50 self-paced training modules that represent a basic and broad introduction to the watershed management field. The module themes include introduction/overview, watershed ecology, watershed change, analysis and planning, management practices, and community/social/water law. "Eight Tools of Watershed Protection in Developing Areas" (<http://www.epa.gov/watertrain/protection/>) describes ways in which nonpoint source managers can address pollution using planning, regulatory, and education techniques.

Residential Pollution Prevention (Household hazardous waste, lawn and garden care, pet waste, car washing)

- **Stormwater Manager's Resource Center, Fact Sheets on Pollution Prevention Practices** (http://www.stormwatercenter.net/Assorted_Fact_Sheets/Tool8-Stewardship/residential.htm): These fact sheets describe various residential storm water pollution prevention practices, such as pet waste collection, car washing, lawn care, car maintenance, and rain barrels.
- **Natural Resources Conservation Service, Backyard Conservation Tip Sheets** (<http://www.nrcs.usda.gov/feature/backyard/>): These fact sheets provide information for homeowners on ways to reduce erosion and manage fertilizer and pesticide application for water quality protection.
- **SWRCB How You Can Help Reduce Water Pollution Web site** (<http://www.waterboards.ca.gov/nps/lookwhatyoucando.html>): describes way for the public to reduce water pollution in various settings, including at home, at work, in the community, etc. The site contains fact sheets on runoff-protection practices pertaining to vehicle maintenance (covering such topics as car washing, recycling of auto fluids, and proper disposal of auto parts) and landscaping and yard maintenance (topics include native plants, garden waste, and pest management), among others. The site contains links to other Web sites with information on pollution prevention and runoff management.

Municipal/Commercial Pollution Prevention

- **California Municipal Handbook** (<http://www.cabmphandbooks.org/>): This manual contains information about storm water quality planning for municipal operations, including permit requirements, planning principles, techniques for reducing runoff and managing impervious areas, source controls, runoff treatment controls, staff training, and inspections and maintenance.
- **California Department of Transportation, Maintenance Storm Water Pollution Prevention Bulletin** (<http://www.dot.ca.gov/hq/env/stormwater/publicat/maintain/>): This is a monthly bulletin that provides technical information on management practices for municipal maintenance activities.
- **USEPA, Phase II Pollution Prevention/Good Housekeeping Fact Sheet** (<http://www.epa.gov/npdes/pubs/fact2-8.pdf>): This fact sheet describes general requirements and provides guidance for the Phase II Pollution Prevention/Good Housekeeping minimum control measures.
- **Stormwater Manager's Resource Center, Fact Sheets on Pollution Prevention Practices** ([http://www.stormwatercenter.net/Assorted Fact Sheets/Tool8-Stewardship/municipal.htm](http://www.stormwatercenter.net/Assorted%20Fact%20Sheets/Tool8-Stewardship/municipal.htm)): These fact sheets describe various municipal storm water pollution prevention practices for pest control, bridge and roadway maintenance, controlling illegal dumping, catch basin maintenance, and parking lot and street cleaning.
- **CalGold, Pollution Prevention Resources** (<http://www.calgold.ca.gov/P2/default.asp>): CalGold was established by the California Environmental Protection Agency to help businesses comply with environmental regulations. The Pollution Prevention Resources include a number of industry-specific fact sheets.
- **USEPA, National Menu of Best Management Practices for Storm Water Phase II, Pollution Prevention/Good Housekeeping for Municipal Operations Fact Sheets** (<http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post.cfm>): USEPA's guidance for small NPDES-regulated municipalities describes practices appropriate for municipal crews to reduce pollutants in storm water at their source, including safe material storage and handling practices, vehicle washing, street sweeping, and landscape maintenance. These practices can apply to residents and business owners and operators, as well.

Public Participation Resources

- **California Stormwater Quality Association, California Stormwater BMP Handbook: Storm Drain Signage** (<http://www.cabmphandbooks.com/Documents/Development/SD-13.pdf>): In addition to providing general information regarding storm drain signage/stencils, this fact sheet outlines design considerations and overall maintenance for these signs.
- **National Tree Trust** (<http://www.nationaltreetrust.org/>): The National Tree Trust provides resources that educate and empower people to grow and care for urban and community forests. The Seeds Program provides grants to urban and community forest organizations for day-to-day operations and offers leadership training, while the Roots Program provides grants to assist project implementation. To date, the National Tree Trust has mobilized nearly \$8 million for urban and community forestry-related programs across California.
- **Project Learning Tree** (<http://www.plt.org/>): Project Learning Tree, an environmental program of the American Forest Foundation, is designed to develop students' ability to make informed decisions on environmental issues and instill in students the commitment to take responsible action on behalf of the environment. The Project's Web site offers environmental curricula, links

to additional resources, grants for educators to implement community action and service-learning projects, and the *GreenWorks! Connecting Community Action and Service Learning Guide*, which provides guidance to educators on how to partner with business, nonprofit, and other community organizations for environmental action projects and to involve students in service learning activities. The *Guide* is available for download through the Project's Web site, or a hard copy can be purchased for a small fee.

USEPA, *National Menu of Best Management Practices: Storm Drain Marking*

(http://cfpub.epa.gov/npdes/stormwater/menuofbmps/invol_6.cfm): This fact sheet describes how a municipality can implement a storm drain marking program using community volunteers or city staff. These signs can raise awareness about the connection between storm drains and receiving waters and can help to deter littering, excess fertilizer use, dumping, and other practices that contribute to nonpoint source pollution.

2.3.17.4 Case Study

Pet Pollution Prevention Pledge, Los Angeles County, California. The Los Angeles County Department of Public Works developed this program to educate residents on the importance of proper disposal of pet waste. The outreach campaign relied on multimedia communication efforts, the distribution of cleanup kits, and the installation of plastic bag dispensers in parks. Local pet and pet supply stores helped with the effort (Lehner et al., 1999) ([http://www.epa.gov/owow/info/NewsNotes/issue53/education53.html - canines](http://www.epa.gov/owow/info/NewsNotes/issue53/education53.html-canines)).

2.3.17.5 References

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